1953

Annual Report

Northeastern Forest Experiment Station

Upper Darby, Pennsylvania
Ralph W. Marquis, Director

1954

United States Department of Agriculture • Forest Service

C O N T E N T S

	Page
INTRODUCTION	1
STATION AFFAIRS	11
FOREST & WATERSHED MANAGEMENT RESEARCH	13
Adirondack Research Center	15
Allegheny Plateau Research Center	21
Anthracite Research Center	24
Coastal Oak-Pine Research Center	27
Delaware Basin Research Center	31
Mountain State Research Center	34
Penobscot Research Center	38
Virginia Pine-Hardwood Research Center	42
White Pine-Hardwood Research Center	45
Forest Genetics	49
FOREST INSECT INVESTIGATIONS	53
FOREST DISEASE INVESTIGATIONS	58
FOREST SURVEY	64
FOREST ECONOMICS	65
FOREST UTILIZATION	66
PUBLICATIONS	71

1953

Annual Report

Northeastern Forest Experiment Station

INTRODUCTION

IN THE NOT-TOO-REMOTE PAST the Northeast has been variously described as not being interested in forestry, as being complacent about the deterioration of its forest stands, as bound by tradition in its forest technology, as failing to apply forest-research findings or to interest itself in forest research.

A recent inspection of the Northeastern region by Forest Service officials showed that such generalized characterization can no longer be made. There are many bright spots in what was formerly considered a dark picture. There are many evidences that forestry in the Northeast is going through the same stages of transition that chacterize other areas; a transition from forest exploitation to forest management. Some signs of this transition are found in changing conditions--physical, technical, economic, and institutional. Some are found in forest practices employed. Others are found in the thinking of forest-land owners and managers.

Without attempting to catalog all the changes taking place in the region or to evaluate their importance, we can

mention a few as illustrative of the dynamic nature of the forestry situation today.

Conditions, Practices,
And Attitudes Are Changing

- The timber harvest may have passed its recent peak. Though final figures are not available, it appears that for the Northeast, and for the Nation, production of forest products in 1953 was less than in 1952. During 1953 inventories of lumber and pulpwood began to accumulate, backlogs of orders went down, and low-quality material became more difficult to market. There was more interest in cutting production costs.

Many expect the decline to continue during 1954. Opinion differs as to whether we are leaving an over-boom period and entering one of prosperity or whether a mild or serious recession is in store. Normal competitive conditions in the forest-based industries might introduce many changes affecting the ability of the very large and very small mills to compete successfully, the markets for low-quality material, the role of new and modernized plants in the production field, the effect on forest-management practices, etc.

- Changes in the pattern of private-land ownership are apparent. Some of the coal companies are putting their surface assets up for sale as the mines are worked out. The forest lands of some textile-equipment plants are being disposed of. A number of pulp companies are expanding their forest holdings. In several areas commercial forest-land holdings are being broken up and sold in small parcels for homes and summer cottages. Municipalities are reaching out for enlarged watersheds to protect their sources of water supply, and there is increasing pressure to set such areas aside for the exclusive production of water without first determining whether water production is compatible with timber operation or other uses.

- Programs to provide more education in conservation have been prepared. In West Virginia there is a plan to get more conservation teaching into the public schools--at all levels. A new handbook is being prepared by teachers, educational supervisors, conservationists, and interested citizens. In New York, representatives of six state agencies have planned a 6-month series of radio broadcasts to inform plantation owners of methods to use to make their plantations pay. The College of Forestry of the State University of New York has added courses in forest influences to its curriculum. In Pennsylvania, Lehigh University has discontinued its conservation curriculum, but will offer con-

servation courses in its biology and geology departments.

• There have been a number of attempts to encourage forestry through a revision of tax systems and procedures. The Pennsylvania Legislature approved a constitutional amendment to permit the separate classification of forest land for purposes of the general-property tax, but the voters turned the proposition down in November. Amended legislation in Maine has established uniform assessment of forest land as a definite objective, the uniformity to be applied according to the productivity of the land. The owner must take the initiative in appealing an assessment and must prove it creates an incentive to abandonment, stripping, or other operation contrary to stated public policy. The New Hampshire experiment in conservation-taxation is creating wide interest. An interim study group is appraising its accomplishments and attempting to discover simplified procedures.

• Forest policy has received considerable attention. In New Hampshire the Governor's Forest Policy Committee presented a progressive and comprehensive report. A study of conservation law in Pennsylvania, prepared at the University of Pittsburgh, was published. The National Planning Association released its study of forestry in New England. The conservation departments of Massachusetts and Pennsylvania were reorganized.

Loans by national banks secured by improved forest properties were authorized. Returns from the sale of Christmas trees were held not to be subject to the capital-gains provision of Section 117 (K) of the Internal Revenue Code.

• Because this was a year of drought in many sections of the Northeast there was a greater than usual interest in water and watersheds. The situation in Maryland was potentially serious at the close of the year. Although the top 5 inches of soil are moderately wet, there is a powder-dry zone below this which breaks the capillary column to the water table. The resulting death of pockets of conifers is already showing up. The situation may affect the proposed planting program for next year.

In many sections of West Virginia streamflow and groundwater levels were lower in the fall of 1953 than in 1930, the year with the lowest record. Municipal water-supply shortages were reported in Pennsylvania, and many trout streams dried up or reached such low levels that the effect on trout population will continue for several years. There were severe drought conditions in sections of New England, particularly in the northern Berkshire area. Some towns had stringent regulations on water use. Emergency

wells were drilled to supplement the usual supply.

These conditions were unusual in their severity, but part of a pattern that has existed for some time in the Northeast. Farmers in New Hampshire have found wells drying up for some years and have had to drill new and deeper ones. Southern New Jersey has felt concern for some time over the adequacy of groundwater supplies to meet the needs of expanding industrial and domestic consumption.

There is sharp competition for surface water, particularly in the rapid-growing Delaware Valley. New York, New Jersey, Pennsylvania, and Delaware are all interested in various aspects of adequate industrial and household supplies, regularity of flow, minimum low-level flow, and quality, as well as the share each can withdraw. The dispute over withdrawal reached the stage of court action some years ago, and as a result the Supreme Court of the United States now has virtual control of withdrawals. The Incodel (Interstate Commission on the Delaware Basin) plan appeared at one time to offer a solution to the problem, but its rejection by a special committee in Pennsylvania has stimulated new attempts to reach agreement.

The Northeast, supposedly a humid area, is becoming concerned about water, and while once this concern was largely over erosion and floods, today it is pointed more and more toward supply and quality. The engineers think in terms of structures to control flow. Foresters think also in terms of land-use and management practices. Interest in expanded research in watershed management is being expressed in all areas of the region.

- The annual cut from the national forests in the region is being increased. This is bringing production closer to the allowable cut for sustained yield and opening up areas for increased growth. Better markets for low-grade material, more roads, and more manpower are needed to bring production up to allowable cut.

In West Virginia the state forests, which had previously been managed primarily for recreation, are beginning to make timber sales. Management for timber production is now a definite objective for state forests in Pennsylvania, and management plans for all state forests are nearing completion. Many other states are continuing to sell timber from state lands and to manage these lands for multiple use.

- There is ample evidence of improved forest practice on private lands. Service foresters, consulting foresters, and other agencies have made notable progress in stimulating better forestry on small holdings. The most spectacular advance, however, has been on the lands of some of the larger industrial companies.

In West Virginia demands for planting stock far exceed supply in spite of expanded nursery production. As the possibility of practicing forestry and protecting watersheds is being demonstrated with new equipment and methods, many operators are becoming interested in better practices. In Maine, at the other extremity of the region, there is increased interest in better cutting practices by all classes of owners. Marking timber for cutting has been adopted as a standard practice by several companies, and is being tried out on a fairly large scale by several others. There is a growing interest in hardwood management. The level of forest practice on private lands in New Hampshire is improving--as evidenced by the increasing percentage of the annual harvest eligible for tax abatement.

These are examples of bright spots that could be expanded to include every state in the region. But they are not representative of the general level of forestry. There is still much progress to be made.

More Interest
In Forest Research

- There is a rapidly growing interest in forest tree improvement. This was strikingly evident in the attendance and discussion at the first Northeastern Forest Tree Improvement Conference held at Williamstown, Massachusetts, last August. Significantly, the greatest interest expressed at present is by industrial forest-land owners rather than by farmers, nurserymen, or dilettantes. Interest is expressed in disease resistance, good form, high quality, and rapid growth--characteristics not possessed by much of the present growing stock. The pulp industry apparently is exploring the possibility of adding to processing revenues through the realization of ground rent from management of rapid-growing trees on short rotations. Concern is expressed about the cost of establishing hardwood plantations. There also are unanswered questions about the utility of fast-grown hardwood species for both pulp and manufactured wood products. There is still much progress to be made in the field of tree improvement.

- The interrelation of wildlife and forest management is a field that has been characterized as neglected. Research in wildlife management *per se* is conducted by the Fish and Wildlife Service of the Department of the Interior. The various state game commissions are also active both in research and in management. But there is evidence of a growing feeling that forest research is not doing its full job until it studies one of the relations--the relation of wildlife population to the regeneration of the most valuable forest

species.

There is evidence from the Pocono and Kane Experimental Forests that heavy cutting in patches or strips results in abundant reproduction of white ash and black cherry. But the openings are attractive to a hungry deer population, and the sprout and seedling reproduction soon disappears. Cutting large areas on this basis might spread the herd and reduce concentrated browsing, but such cutting might not be consistent with sustained-yield objectives, minimizing fire hazards, or protecting watersheds. More knowledge is needed before the proper correlation of game and timber management can be realized.

- Forest insects and diseases continue to plague the Northeast. A severe outbreak of the forest tent caterpillar affected more than 7 million acres in New York alone and spread into other states. In New England some million and a half acres were defoliated by the gypsy moth. In the Madawaska Lake area in Maine spruce budworm populations have built up to a level where spraying of 20,000 acres next spring will be required. Red pine stands in Connecticut and lower New York are becoming infested with Matsucoccus sp. Though oak wilt distribution has remained unchanged in the Northeast, it remains a threat to forest and shade trees. A disease of yellow-poplar is under close observation, as is an unexplained mortality of fir in Maine.

Damage done by forest insects and diseases is of increasingly great concern. Damage surveys more accurate than those of the past are being made. There is increasing interest in detection, surveys, control, and development of resistant forest-tree strains.

- During the last year or two a number of groups have considered the programs of research of various agencies and have made constructive suggestions for their conduct.

"Forest Policy for New Hampshire," the report of the Governor's Forest Policy Committee, recommended that research be stepped up; it outlined the fields in which forest research would be most productive. The report of the subcommittee on forest research of the New England Council Committee on Forestry and Forest Industries outlined the progress of research in ten fields and made recommendations for its continuance and correlation. The Northeastern Forest Research Advisory Council continues to increase its effectiveness in stimulating, supporting, and guiding the program of the Northeastern Forest Experiment Station and other research agencies of the Northeast. Many industrial firms and associations are active in initiating, sponsoring, or cooperating with research activities.

Beyond the regional boundaries, the same helpful guidance is being given to forest research. The national

Forest Research Advisory Committee, meeting in October 1953, gave detailed consideration to and made strong recommendations regarding a large number of projects in the fields of production, utilization, and marketing research. The fourth American Forestry Congress, also meeting in October, noted certain fields in which research has lagged, emphasized the need of maintaining fundamental research in proper balance with applied research and practice, and urged greater consideration of objectives regarding the kinds of trees to be grown and the amount of time to be expended in the process.

Considerable attention was given to forest research by the Mid-Century Conference on Resources for the Future. Knowledge gained from fundamental research was characterized as one of our basic resources. Neglected fields of research were listed as including insects and disease, watershed management, forest genetics, utilization of low-quality woods, and economic aspects of forest management. The need of increased basic research was emphasized. The survey of research currently being conducted by the Society of American Foresters is expected to add much to our understanding of needs, responsibilities, and opportunities.

The Challenge To Research

Research takes time. There are always intervals between the recognition of a problem, the conception of an experiment, and the summary of results and conclusions. But research, if it is to be of greatest value, must have answers ready when the practitioners of forestry call for them. Hence the need of a great amount of fundamental knowledge. And hence the need to think far ahead of current practice.

Research does not establish policy. It merely helps to provide the answers to questions that must be considered in establishing policy. But research workers must be aware of the policy decisions that will be coming up, and of the many fields of inquiry that will be called on to contribute when decisions are made.

Following are two examples of important problems in the Northeast and of the many research implications in these problems.

The So-Called Low-Quality Problem

The forests of the Northeast are composed of some excellent growing stock of valuable species, but also of a large quantity of low-quality material, principally hardwoods. The problem of the low-grade material can be stated simply. Much of it cannot be sold at a price that will cover

harvesting costs; but if it remains in the woods it reproduces itself and takes up growing space that could be used by plus-value trees.

The solution of the problem is not so simply stated, but it seems to lie in three possibilities, or a combination of them. The first is an increase in the value of the currently submarginal material. The second is a reduction in the cost of harvesting it. The third is a change in the relative cost of getting rid of it and the productive value of the growing space thus released.

The value of low-quality wood is to some extent a function of its location. It varies inversely, though not necessarily proportionately, with the distance from plants that can utilize it. Material that today goes begging in the Allegheny Mountains might find a ready market if it were growing in highly industrialized Connecticut. Increased value can come through increased demand for present uses, through new uses, or through the establishment of utilization plants closer to the source of supply. In varying degree all of these are taking place in the Northeast.

The most spectacular development in new or expanded use is the greatly increased consumption of hardwood in the semi-chemical and chemi-ground pulp mills recently established. For example, the Great Northern Paper Company mill at East Millinocket, Maine, is now using about 50,000 cords of peeled hardwood per year. In another year or two this may be stepped up to around 90,000 cords. Suddenly hardwoods in the area of such a mill are transformed from weed species to valuable crops. But the help from the pulp industry, important as it is, cannot be expected to solve the low-grade problem for all the region. And as an illustration of a counter trend; the demand for mine timbers is declining as unprofitable or worked-out collieries are closing, coal production declines, and metal roof supports come into greater use.

Advances have also been made in woods technology, which makes harvesting cheaper, and in plant technology, which can permit increased margins for stumpage. The chemical girdling of trees to expedite debarking has become perfected as a highly important woods measure. The Northeast is now treating 150,000 cords annually--about two-thirds of all the chemical girdling in the country. Mechanization is definitely coming to the woods. One power-saw dealer in West Virginia reports for his sales area more than 300 users of his power saw today. Five years ago there was not a known power saw used in the area. In 1950 about 50 percent of the logging, region-wide, was done with power saws. Today the percentage is estimated to be about 85. Tractors in use today are better adapted to needs; sulkies and winches are coming into use; log loaders are no longer rarities. Road layout is improving to permit longer logging seasons and to

reduce hauling and skidding costs. Any savings in logging costs permits the removal of more low-grade material. Any increase in the supply of this material at lower delivered prices is an attraction to utilization plants.

Increased demand, better markets, and lower production costs will help move more material now characterized as low-grade to market. But there probably will be some material in most stands too poor to harvest, and some areas that will benefit less from increased utilization than others. If the market fails to take submarginal stems the so-called low-grade problem can be solved only by getting rid of them. Much progress has been made in the application of poisons to kill unwanted trees, and in reducing costs of application. More must be done in determining how much value results in improved stand conditions and increased growth when minus-value trees are removed. Some means of financing the capital expenditure involved in poisoning may have to be found for many landowners, especially those who are not able to sell any of their timber in present markets.

It took 300 years of misuse to bring the forests of the Northeast to their present condition. The challenge to forestry is how much less time it will take to restore the resource to one of universal utility.

The Problem Of What To Grow

When forest management was largely a matter of textbooks and academic discussion, silvicultural systems held the spotlight. But today, as plans are made for the actual management of forest lands on a commercial basis, knowing what to grow is as important as knowing how to grow it.

Part of the answer lies in the future, and can be seen today only dimly, through the observance of trends. We cannot foretell exactly what the total demand for wood will be when today's seedlings and saplings are ready to harvest. We do not know what species will command the highest price. We may think that the size of trees and logs will continue to be important in commanding markets, but we are not sure that technological advances will not make material of any size acceptable. But the decisions have to be made today.

The choice of species to grow is not always a wide one; in some parts of the country it may be a very narrow one. But in the Northeast, with its mixed stands and wide variety of forest species, a choice is usually possible. An owner who has decided, in his own mind, which species will be most valuable in the future, has other decisions to make. Should it be grown in pure or mixed stands? Is the site favorable? Would he be fighting nature in trying to establish the favored species, or working with nature? Are there other species whose final market value would be less, but

which would give him a higher net return?

The forest survey is helpful in disclosing what species are present today, but it may be misleading; present species may not be the best adapted to the site. Fire, cutting, neglect, and other factors may have so changed the composition of the stand that the present species are poorly adapted to the site. What is badly needed is more precise information about soil, drainage, aspect, and other characteristics of site in relation to growth, form, and quality.

Once a decision has been made as to which species are to be favored, other problems arise. The manager must decide whether the transition can be accomplished best through the management of present stands or whether artificial regeneration will be required. If there is a choice so far as biological considerations are concerned, he must decide which would be the most economic method. If the transition can be accomplished through management, he must determine how rapidly it should take place. If through planting, he must explore the possibilities of using new genetic strains.

After the method of conversion to the desired composition is determined, there remains the question of rotation. The probable relation of size and quality to future values must be considered, as well as the probable relation of tree size to harvesting costs. And the owner, concerned with financial return, must decide first whether he wants to maximize net return per acre of land or net return on invested capital; and second, what rotation system will accomplish this.

Decisions are probably easiest for the integrated operation--the ownership that includes both an established processing plant and forest land. The pulp company may decide to go one way, the furniture dimension company another, the box company still another. For each of them there is some indication of stability in a currently controlled demand.

The landowner without a processing plant has no control over demand, present or future. If his is a good white pine site, he must decide whether to manage his forest land for pulpwood or sawtimber production or both. He must judge the future carefully, but he is concerned primarily with trends of utilization within a fairly small marketing radius.

The managers of public lands have the hardest decision to make, for their responsibility is to all the people of the state or nation. To what extent should they be concerned with future security and maintain a reserve on public lands managed for long rotation and heavy stocking? To what extent are they justified in sacrificing maximum revenue for the public if caution dictates less profitable operation?

Decisions will vary, and some of them will be wrong. The significant thing is that the people of the Northeast

are thinking of the future and preparing management plans for their forest resources.

STATION AFFAIRS

• A REORGANIZATION WITHIN the Forest Service has transferred the work of preliminary examinations and surveys in the flood-prevention program from research to the branch of State and Private Forestry in the Washington Office. Activities in the field have been transferred from the Experiment Stations to the Regional Offices. The Station continues to cooperate in this work by supplying resource and other information. Several Station people have been detailed to the Region for short periods to aid in investigations related to the small-watershed program.

• As part of the Department of Agriculture reorganization, work in forest-disease and forest-insect surveys and investigations has been transferred to the Forest Service. On January 1 the Northeastern Forest Experiment Station assumed responsibility for the programs in the Northeast formerly under Entomology and Plant Quarantine and Plant Industry. Headquarters for these activities will continue, for the time being at least, to be in New Haven, Connecticut. Under the new organization it is hoped that even closer coordination of detection and control activities, forest management, genetics, survey, and forest utilization can be effected in safeguarding our forests from insect and disease losses.

• Several studies ignored division lines and occupied the attention of all Station personnel. One of these was the Timber Resource Review. The Station has primary responsibility in the Northeast for Tasks V, VI, and VII (timber drain and wood utilization, timber resource inventory, growth goals, and now part of status of protection). Work is progressing satisfactorily in all fields, and we hope to meet all deadlines and complete field work by this summer. Adherence to the schedule without serious interruption of regular work has been possible only because of the cooperative participation in the study by state forestry organizations and a large number of industry representatives.

• Another Station-wide activity was the revision of instructions for keeping compartment records. The revision has attempted to simplify record-keeping and reduce the work load at the research centers. While standardizing objectives, it has also provided more flexibility in the methods of meeting these objectives. Inevitably the consideration of record-keeping led to a more careful consideration of how these records will be analyzed. Our next task will be to establish guides for analysis. Already records are available for several annual cuts on the farm-woodland compartments, and in a year or two we will have records following the second cut on compartments managed on a 5-year cutting cycle.

• Marinus Westveld, who retired a year ago, has continued with the Station as collaborator. Continued work in preparing his manuscript on spruce-fir silviculture and management has brought it near to completion. Thomas F. McLintock returned to the Penobscot Research Center after a year spent in graduate study at Yale University.

• The Station continued to disseminate its research findings through publication of articles in professional and trade journals and magazines, and progress reports processed in the Station's printing plant. The number of publications by staff members and cooperators during 1953 was 73, a slight increase over last year (70 items published). The publications during the year are listed at the end of this report, with abstracts describing briefly the contents of each. Besides the articles published, 32 articles submitted to outside publishers during the year have been accepted but not yet published.

FOREST & WATERSHED MANAGEMENT RESEARCH

IN THE PAST we have reported yearly progress in forest-management and watershed research under a more or less artificial subject-matter classification. The year's advances in knowledge of silvics, silviculture, costs and returns, infiltration, streamflow, groundwater, soil freezing, and other subjects have been presented for the Station as a whole. Out of this practice there may have developed the impression that the Station has only a single program of research in forest and watershed management for its entire territory.

This year we are departing from the traditional pattern of reporting. By doing so, we believe we can show more clearly how the Station's work is geared to the needs of the people and the forests of the Northeast. And we can also show how the Station is organized for such research, something that has not been done before in an annual report.

This year's report discusses the forest- and watershed-management research by the nine subregional research areas now recognized for the Station's territory (fig. 1). Information on the extent, ownership, and forest types within them (tables 1, 2, and 3) helps to bring out the individuality of the different areas.

Recognition of the differences among these areas had been growing for some time, and in 1946 the Station was reorganized to deal more effectively with their problems. A unit of the Station, a research center, was established for each area, with local headquarters. The problems of each area were analyzed and a program of research was planned to solve the most important in each. Programs are necessarily tailored to the resources available to the Station and its cooperating agencies.

The analyses and programs take into account the great diversity of forest, social, and economic conditions that exist in the region. Typical of the diversity in conditions are the large areas of Maine that lack local government and permanent settlements; metropolitan areas in New England and the Middle Atlantic States; virgin forests in the Adirondacks; and the abused remnants in the coal regions and Southern New Jersey. There are wide differences in attitudes toward forest and watershed management. Within the boundaries of the region can be found pure stands of even-aged conifers, and complex mixtures of many species; all degrees of topography and soil fertility; and markets ranging from excellent to none. How these conditions combine in the

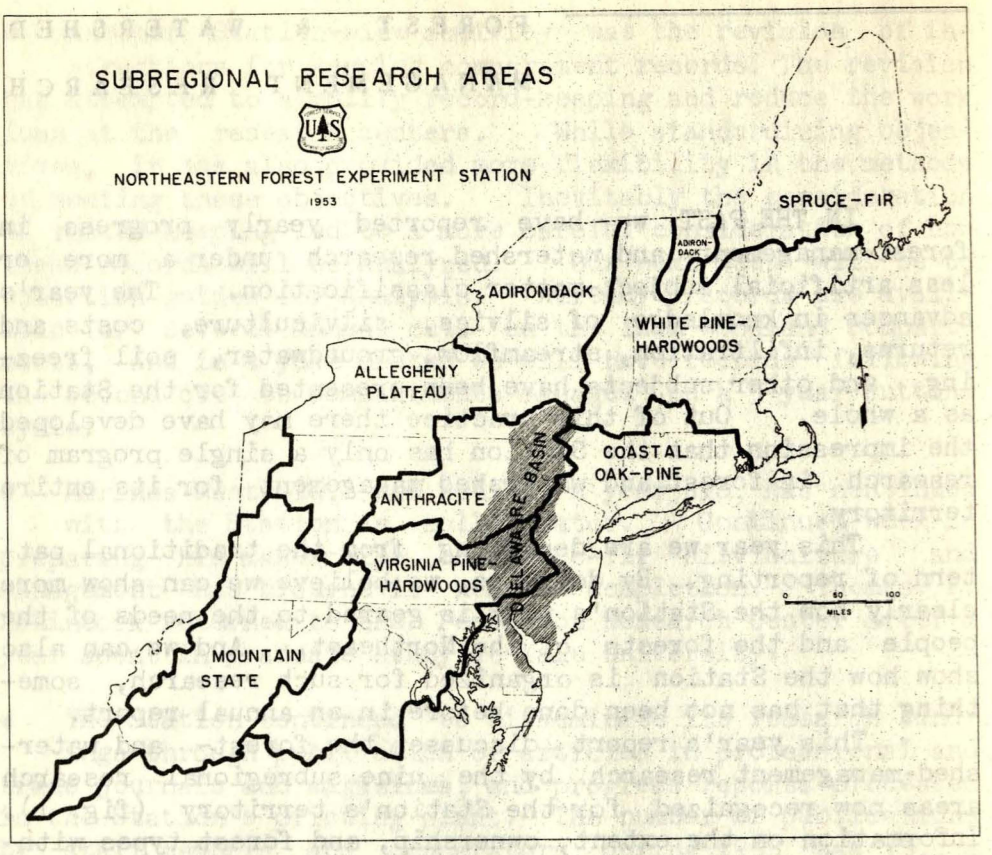

Figure 1.--The subregional research areas in the Northeast. The Delaware Basin area, in which watershed management is the main concern, overlaps several of the other research-center areas.

different subregional research areas to create particular problems is brought out later.

Some broad general conditions in need of study seem to be present in all of the subregional areas; stand rehabilitation, how to get rid of low-value trees most cheaply or profitably, how to obtain regeneration of desirable trees effectively and reliably, how much and what kinds of care and cultural work can be justified by results, and similar questions that confront the forest manager who sees his job as the business of growing timber as a crop. There thus emerges a regional pattern for the Station's program.

Through guidance, conference, and control at the Station level, the programs at the research-center level are coordinated to permit replication of studies where needed, to concentrate work in a special line where it can be done most effectively and yet yield results applicable elsewhere or to the region as a whole, and to maintain a desirable

balance in the effort devoted to different lines of study. The programs of forest and watershed management for the research centers thus constitute, in most instances, compromises between over-localization and provincialism on the one hand and unrealistic technical abstractions on the other.

Although the Station organization was changed in 1946 to provide research centers to work on the forest- and watershed-management problems of the subregional areas, it took a couple of years to get the programs crystallized and the work under way. So in effect we are now reporting on 5 years of operation under the plan. It seems appropriate to devote this year's report on our management research to presenting a picture of this aspect of the Station's program and organization.

ADIRONDACK RESEARCH CENTER

Area Served

The Adirondack Research Center conducts the Station's forest-management research in an area of some 14 million acres in northern New York and Vermont (fig. 1). Although forests cover 60 percent of the area, those on 13 percent are not available or suitable for commercial forest production. Topography varies from plateau and foothills to steep mountains. Forest types are generally related to topography and, since the area has been glaciated, changes in forest type are often abrupt. Soils are varied but generally thin, stony, and acid--and not well suited to agriculture.

The ownership pattern for forest land is dominated by industrial holdings (table 2). And among the industrial ownerships, those of pulp and paper companies are most extensive. Much of the noncommercial forest (table 1) is publicly owned land in parks and preserves unavailable for commercial operations. In keeping with the generally low suitability of the area for agriculture, farm forests are less extensive than in other areas.

Cutting began more than 100 years ago; loggers concentrated on pine and spruce for lumber and pulp. High-quality maple and birch have found a ready market in the last several decades. Such high-grading and differential cutting has adversely affected both composition and quality of growing stock.

With reduction in the quantity of spruce, fir, and other softwoods available, a number of pulp and paper mills

have been torn down after losing out in competition with other forest regions. Other mills are beginning to use hardwoods increasingly, and more change in that direction is expected in the future.

Table 1.--Estimates of land and forest area in the Northeast, by subregional research area, 1953

(In thousands of acres)

Subregional research area	Forest land[1]			Nonforest land	Total land area[2]
	Commercial	Noncommercial	Total		
Adirondack	6,955	1,862	8,817	5,332	14,149
Allegheny Plateau	7,069	75	7,144	8,462	15,606
Anthracite	7,269	84	7,353	4,360	11,713
Coastal Oak-Pine	8,510	250	8,760	7,772	16,532
Delaware Basin	3,659	18	3,677	4,493	8,170
Mountain State	13,445	64	13,509	7,828	21,337
Spruce-fir	14,898	146	15,044	1,967	17,011
Virginia Pine-Hardwood	7,635	192	7,827	9,550	17,377
White Pine-Hardwood	13,144	458	13,602	6,643	20,245
Total, research region[3]	78,925	3,131	82,056	51,914	133,970

[1] Estimates based on Forest Survey and Reappraisal data. [2] Census of Agriculture, 1950.
[3] Does not include Delaware Basin area, which overlaps other research-center areas.

Recreational values of the forest lands here are among the highest in the Northeast. Being within striking distance of the Nation's heaviest population concentrations, all kinds of forest recreation are intensively developed and enjoyed. Such use is almost certain to increase still further with increasing leisure of an expanding urban population.

Headquarters for the Adirondack Research Center are maintained at Paul Smiths, New York, in cooperation with Paul Smith's College.

Problems

1 The widespread and obvious forest-management problem apparent in the area is: How to correct the bad effects of past cutting and mishandling? The solution calls for not only further knowledge of biological relationships of the forest, but also an economic evaluation of alternative courses of action that may be developed.

As a beginning we must derive a better understanding of the silvical and ecological requirements of the tree species, particularly as to soil and topographic elements of site. From such information, guides to forest composition can be developed. Over great areas the problem will boil down to devising means of increasing the softwood components

of the stands and to finding ways--biological, mechanical, or chemical--of relieving the land of the burden of poor growing stock.

2 Progress in improving composition, growth, and quality of the forest resource could be stepped up if ways of harvesting and utilizing the poor hardwood growing stock could be found. Even near-marginal utilization would obviously be more attractive financially to forest owners than investment in hardwood-control measures. The current trend toward increasing use of hardwoods for pulp is in the right direction, but the supply of low-grade material is great enough to justify other outlets of major size. New forest industries would be welcome additions to the regional economy. It seems likely that along with studies on new uses for poor hardwoods, other studies will be needed to lower the cost of harvesting such low-value raw material.

3 The problem of managing forest lands to achieve high production without conflict with recreational values must be solved, particularly for the Adirondack Plateau and Mountain area. Harvesting methods and silvicultural measures aesthetically acceptable or desirable from the recreation viewpoint (or productive from the game-management viewpoint) might even justify a slight lowering of yield if that is necessary. A corollary problem is to bring about a pattern of seasonal recreation and forest-industry employment that will effectively use the local labor supply.

4 How to minimize losses to insects, disease, and weather damage is another broad problem of forest management in this area. Red heart (Fomes pinicola) of spruce and other conifers is widespread, as in the obscure "dieback" of yellow and white birch. Red heart is responsible for major losses in spruce and balsam fir. Where present it usually requires heavier cutting as a salvage operation than would otherwise be desirable. It is difficult to recognize in the early stages of infection, and work is urgently needed to find out how to recognize it and to determine which trees are susceptible. Birch "dieback" seems to affect mature and overmature stands mostly, but is found in others. There is enough obscurity and disagreement about its cause--but not its destructiveness--to make further study imperative. In the aggregate, damage by such weather elements as wind, snow, glaze, and low temperatures is large. We need to learn more about species tolerance of such elements and their occurrence in the region so that forest composition can be directed toward resistant forms.

Table 2.--Estimates of commercial forest land in the Northeast, by ownership and subregional research area, 1953

(In thousands of acres)

Subregional research area	Private			Public[1]				Total commercial forest-land area
	Farm forests[2]	Industrial and other	Total	Federal	State	County and municipal	Total	
Adirondack	1,792	4,642	6,434	52	417	52	521	6,955
Allegheny Plateau	1,770	3,537	5,307	472	1,266	24	1,762	7,069
Anthracite	1,603	4,326	5,929	3	1,265	72	1,340	7,269
Coastal Oak-Pine	2,095	5,934	8,029	87	266	128	481	8,510
Delaware Basin	841	2,379	3,220	35	396	8	439	3,659
Mountain State	4,170	8,063	12,233	889	319	4	1,212	13,445
Spruce-fir	1,466	13,184	14,650	195	45	8	248	14,898
Virginia Pine-Hardwood	2,768	3,704	6,472	825	270	68	1,163	7,635
White Pine-Hardwood	4,018	8,003	12,021	688	266	169	1,123	13,144
Total, research region[3]	19,682	51,393	71,075	3,211	4,114	525	7,850	78,925

[1] Estimates based on Forest Survey and Reappraisal data. [2] Census of Agriculture, 1950.

[3] Does not include Delaware Basin area, which overlaps other research-center areas.

Research Program

The work at this Research Center is largely concentrated on the Paul Smith Experimental Forest, Paul Smiths, New York. This 2,200-acre tract is part of the holdings of Paul Smith's College and has been made available for research by lease to the Forest Service. Some work is also being done in the Finch Pruyn Experimental Forest, a 600-acre tract near Newcomb, New York, made available by Cornell University. Other studies, by nature and design, are conducted off the experimental forests where suitable conditions are found. The present program includes:

1 A site-classification study designed to develop a set of criteria, readily recognizable in the field, for identifying and rating the potential softwood-producing areas.

2 Studies to improve and develop techniques for deadening cull hardwoods. Simplified mechanical methods of applying sodium arsenite are being sought in an effort to reduce costs while maintaining effectiveness. Safety and reduction of danger to wildlife are other major objectives in studies with this poison.

3 An experiment in applied silviculture and practical management, employing compartments as treatment units. The experiment is on a scale that simulates commercial operations and will permit economic as well as biological evaluation of the results of several levels of management. The study is now confined to stands with an appreciable softwood component. Future work may extend into hardwood stands.

4 A management unit has been established in cooperation with the St. Regis Paper Company on the latter's Northern New York Experimental Forest. Advice, guidance, and technical assistance will be provided by the Center staff in principles of organization, methods of cutting, desirable cultural practices, and analysis and interpretation of the data obtained. The management unit is essentially a sustained-yield unit on which the most promising practices developed by other research will be put to practical test.

5 Silvicultural studies employing small plots are under way at several points. They are directed at problems of getting regeneration, and methods of harvest cutting.

Research Results

Although the Center has been operating only about 5 years, some preliminary and short-term results are already available.

Table 3.--Estimates of commercial forest land in the Northeast, by forest-type group[1/] and subregional research area, 1953

(In thousands of acres)

Subregional research area	Softwood types					Hardwood types						All types
	White pine	Hard pine	Spruce-fir	Other	Total	Northern hardwood	Oak	Aspen	Yellow-poplar	Other	Total	
Adirondack	--	--	1,069	623	1,692	3,528	--	807	--	928	5,263	6,955
Allegheny Plateau	238	--	--	50	288	2,779	2,193	968	--	841	6,781	7,069
Anthracite	1,650	88	--	17	1,755	2,301	2,771	--	--	442	5,514	7,269
Coastal Oak-Pine	--	2,063	--	1,135	3,198	--	4,577	--	42	693	5,312	8,510
Delaware Basin	549	220	--	146	915	1,024	1,500	110	--	110	2,744	3,659
Mountain State	--	730	--	318	1,048	1,710	7,693	--	1,913	1,081	12,397	13,445
Spruce-fir	---	--	9,155	328	9,483	2,026	--	740	--	2,649	5,415	14,898
Virginia Pine-Hardwood	--	1,895	--	206	2,101	--	4,540	--	--	994	5,534	7,635
White Pine-Hardwood	3,066	--	1,102	67	4,235	4,237	--	850	--	3,822	8,909	13,144
Total, research region[2/]	4,954	4,776	11,326	2,744	23,800	16,581	21,774	3,365	1,955	11,450	55,125	78,925

[1/] Estimates based on Forest Survey and Reappraisal data. Blanks do not necessarily mean than any particular type is not present, but the acreage may be too small for an independent estimate and it has been combined with another type group.

[2/] Does not include Delaware Basin area, which overlaps other research-center areas.

The most effective deadening treatment for cull hardwoods was found to be summer application of sodium arsenite in holes holding 2 to 3 cc of solution and spaced 4 to 8 inches apart around the circumference at waist height. Holes can be made with a power-driven auger bit or with a special hole-punching hammer. After about 2 years the bark loosens so the wood can be used for pulp. Beech, birch, and maple can be treated effectively.

Large cumulative losses in stand volume are due to such weather factors as heavy wet snow, glaze, wind, very low temperatures, and drying winds and sunny weather when the ground is deeply frozen. The damages consist of breakage, uprooting, frost-cracks, and death of smaller components of the stands.

Where beech (a characteristically poor species in the Adirondacks) is present, light selection harvest cuts favor it over the more desirable maple and birch.

ALLEGHENY PLATEAU RESEARCH CENTER

Area Served

The area served by this Research Center covers 15.6 million acres in northwestern Pennsylvania and southwestern New York. Only 45.8 percent of the total is forested and 45.3 percent of the total is commercial forest land (table 1). The nonforest areas are chiefly in the north-central lowlands and Lake Ontario plain of New York and the more westerly and southerly counties of the area in Pennsylvania. The Lake Erie plain and western counties of Pennsylvania are omitted as being more nearly the farm-woodlot type of the Central States (fig. 1).

Geologically the area may be divided roughly into two parts: (1) the northern Allegheny Plateau section, and (2) the central lowland of New York and the Lake plains section. The former is a dissected plateau, the latter rolling hills and valleys at lower elevations. Drainages include the headwaters of the Allegheny and the west branch of the Susquehanna River, the Genessee River, and the Finger Lakes Region. In addition, many short drainages empty into Lake Erie and Lake Ontario.

Forest-type groups represented are 2.4 million acres of mixed oak-white pine and 4.6 million acres of Allegheny or northern hardwood-hemlock and other types (table 3). About 75 percent of the commercial forest land is in private ownership (table 2), and a third of this is in small farm-forest holdings; 18 percent is state, county, and municipal; and 7 percent is Federal ownership (Allegheny National Forest).

Headquarters for this Research Center are on the Kane Experimental Forest, in Elk County, Pennsylvania. This land is part of the Allegheny National Forest.

Problems

Past logging practices and fire have caused widespread forest deterioration in this valuable timber-producing, watershed, and recreation area. Despite this, Nature has done a remarkable job of reclothing much of the cutover and burned land with second- and third-growth forest. Within the 4.5 million acres of the High Plateau section, stands of virgin hemlock-beech-maple were often followed by desirable second-growth black cherry-maple forests which are now rapidly approaching commercial size. How to manage these valuable second-growth stands by pulpwood thinnings and harvesting of veneer and sawlog products, while at the same time perpetuating black cherry and maintaining or building up the growth rate and stand quality, pose some of the most crucial problems requiring answers.

Broadly, there are three fields of forestry with problems that require solution: forest management and silviculture, including the rehabilitation of depleted forest lands by reforestation; water-resource management; and forest economics.

1 The more important problems in forest management and silviculture are: to find what methods of harvesting sawtimber and pulpwood will maintain and increase forest productivity; what timber-stand improvement measures can be used to improve the species composition, quality, and structure of existing natural and planted stands; and what site preparation, early care, kind of planting stock, or direct-seeding technique will assure successful reforestation of lands subject to severe microclimatic conditions, shrubby and herbaceous competition, and heavy browsing by deer and rabbits.

2 In the field of water-resource management, studies are needed on the effect various kinds of forest and brush cover have on interception and infiltration of precipitation and on the detention, flow, and purity of water. Related studies would determine the effect of cultural and other management and silvicultural treatment of watersheds on quantity and quality of water yield. Watershed values are now usually ignored on logging operations. Whether and to what extent present practices should be changed needs to be determined.

3 In forest economics, determination of the costs and returns of various cultural and harvesting methods for all-aged and even-aged management would aid both private and public owners in selecting and adopting management programs that are financially as well as technically sound. Growth and yield being forms of forest income, data from compartment-management and plot studies are needed for a wide range of conditions and management programs.

Research Program

Because of limitations in funds and personnel, the present program is devoted mainly to the solution of three important forest-management problems. The studies are concentrated chiefly on the 1,737-acre Kane Experimental Forest. A few studies have been conducted on private lands in cooperation with private industry.

1 Harvest-cutting-method studies are designed to test productivity of different growing stocks as controlled by diameter-limit cutting and high, medium, and low growing stocks under a single-tree selection system. Different methods of cutting second growth to favor black cherry reproduction are being tried in another series of tests. The objective of a third group of experiments is to devise intermediate harvest cuts that remove cordwood in commercial operations and leave higher grade material to grow for veneer and sawmill requirements.

2 Research on stand-improvement methods falls into studies of thinning and weeding in young growth; of cultural treatments in second-growth stands approaching maturity; and of salvage operations in and recovery of stands damaged by glaze storms. Artificial regeneration studies are limited to test plantings and study of existing plantations, and to racial studies of geographic strains of red pine to determine local adaptability.

3 In the field of water-resource management no studies are under way. Forest-economics studies as such are not included in the present program, although other studies of various plots and cutting-practice blocks provide data on growth and yield of managed and natural stands.

Research Results

Research on Allegheny hardwoods-hemlock has shown the desirability of leaving an adequate growing stock of good-risk trees in both sawtimber and cordwood stands. Partial cutting on a 10-year cutting cycle will leave the stand in best productive condition.

Clear-cutting or removal to a low diameter limit, if done on sizable areas and followed by fires and browsing by deer and rabbits, can impair the stand and microclimatic, preventing natural regeneration over a period of 40 or more years. Small group openings or long narrow strips cut to a low diameter limit are promising for the intital growth of black cherry seedlings to perpetuate this valuable species.

Red pine is the most promising species for planting to rehabilitate old fields and old burns. Stock from seed collected in central Wisconsin and the Lower Peninsula of Michigan has shown up best in early growth.

Weedings benefit selected crop trees for 10 to 15 years after treatment. Early thinnings markedly increase growth and yield and improve stand quality.

Past studies of the ecology and silvics of the chief species in virgin and second-growth stands have shown that establishment and development of regeneration are dependent on species requirements and are influenced by climate, soil, fire, windthrow, animals, and other biotic factors as well as competition within the stand.

Conversion cost studies show better earnings for the woodcutter, and greater cubic-foot volume production for industry, can be obtained by cutting trees above 8 inches in diameter instead of following the usual practice of clear-cutting.

In general, growth and yield are directly correlated with volume of growing stock in both natural and managed stands. A recent study of 255 sample trees cut and measured in cooperation with the Armstrong Forest Company and the Allegheny National Forest has provided reliable volume tables in terms of cubic feet and standard cords of rough wood for Allegheny hardwoods 6 to 24 inches d.b.h. Tests by xylometric methods were made on 88 bolts. Differences due to species were negligible for trees of a given diameter, merchantable height, and form class. A cubic foot/cord converting factor of 85 was found to apply to all tree sizes studied.

ANTHRACITE RESEARCH CENTER

Area Served

The area served by the Anthracite Research Center includes the southern tier of five counties in New York State that lie in the Delaware River watershed and the eastern part of the upper Susquehanna drainage, and all of the northeastern quarter of Pennsylvania. It is 11,700,000 acres in area. The topography of the area ranges from the long

steep slopes of the Catskills, through the Poconos of northeastern Pennsylvania, with their high plateau dissected by steep-sided canyons, and extends to the southwest through the parallel narrow ridges and valleys that run across central Pennsylvania.

Approximately 63 percent of the area is forested; less than 1 percent is noncommercial forest. Major forest-type groups represented are northern hardwood (beech-birch-maple), mixed conifers and hardwoods (white pine-hemlock, white pine-oak), and mixed oaks. Approximately 82 percent of the forest land is privately owned. About 18 percent is in state and other local public ownership; Federally owned forest land is less than 1 percent.

The area includes the principal anthracite-producing counties of Pennsylvania. The forests in that part of the area around the coal region have furnished a large portion of the timber requirements of the mines. Headquarters for this Research Center are in Kingston, Pennsylvania.

Problems

An outstanding problem in forest management in this area is to rehabilitate the existing stands that have been subjected to repeated heavy cutting and frequent burning. This is a problem that cuts across all forest types. As part of this major over-all problem the following problems must be solved:

1 How to obtain a better balance of species by promoting a greater proportion of the more desirable species.

2 How to reduce the amount of culls and undesirable species without incurring prohibitive expense.

3 How to manage the stands so as to provide a good flow of high-quality and bulk products.

4 How to convert even-aged unmanaged stands to all-age managed stands.

5 How to utilize and market low-grade hardwoods.

6 How to manage the deer population so as to prevent the extensive damage from browsing off the most desirable tree reproduction.

Another important over-all problem is how to increase the commercial forest area by converting land now covered with brush or other nonproductive species, planting abandoned farms or pastures, and planting strip-mine spoil banks.

This gives rise to a number of subordinate problems:

1 What species are suited to the different sites as reflected by different soils, climate, and exposures?

2 What types of site preparation are necessary to insure success in planting?

3 What weedings and thinnings are needed to produce the desired type of stands, and how can this be done economically?

Research Program

A major portion of the present research program being carried on at this Research Center is concentrated on the Pocono Experimental Forest near Gouldsboro, Pennsylvania. This 2,000-acre experimental forest is operated in cooperation with the Monroe Water Supply Company, a subsidiary of the Lehigh Coal and Navigation Company. Studies now under way are directed toward determining costs and returns, volume and quality production, and silvicultural effects under different cutting practices.

A 600-acre watershed on the experimental forest is being studied to determine the effect upon water yields, both as to quality and quantity, of harvesting the timber through the use of good cutting practices. Also under way on the experimental forest are exclosure experiments to find out the effects of deer and rabbits upon tree reproduction. A region-wide study of the use of silvicides and brush killers for control of vegetation on roadsides, along telephone lines, trails, ski areas, etc., on National Forests is also assigned to this Research Center. Its objective is to find a cheaper and more effective method to replace mowing.

Elsewhere in the Pocono Mountains, studies are being carried on to develop methods for converting unproductive scrub oak to commercially valuable forest at a reasonable cost. These studies involve tests of various species, classes of planting stock, and methods of preparing the site for planting. Most of the scrub oak conversion studies are being carried on at the Delaware-Lehigh Experimental Forest in conjunction with the Delaware Basin Research Center and in cooperation with the Pennsylvania Department of Forests and Waters.

Another study, carried on cooperatively with the Lehigh Coal and Navigation Company, was established for the purpose of determining whether young (pole-size) stands of oak could be partially cut according to good silvicultural principles with some net return to operator and landowner, and still reserve an adequate stand of the best trees for growing stock.

Research Results

Since the establishment of this Research Center, considerable information has been obtained as to the condition of the forest lands as a whole and for specific forest types that occur in this area.

Establishment of the studies on the Pocono Experimental Forest has not been completed, but some interesting information has been obtained. For example, a number of different chemicals have been tested for the purpose of deadening culls and other undesirable trees. Results have been promising though quite variable, depending upon the tree species involved; and in a number of cases results have differed considerably from those obtained in other parts of the Northeast.

The deer and rabbit exclosure plots have demonstrated very clearly the tremendous inhibiting effect that wildlife have upon reproduction of the more desirable tree species. As a matter of fact, it appears that, in this general area, successful restoration of a good productive forest stand may depend to a considerable extent upon control of the deer population.

It has been found that young oak stands may be thinned according to sound silvicultural principles at a profit--through sale of the thinnings for small mine timbers.

In the scrub oak conversion studies, the better adapted species and the basic requirements for successful planting have been determined insofar as species adaptability can be revealed in 5 years. In general, we are now in a position to specify how planting should be done, but have not succeeded in getting costs low enough to be attractive to most landowners. Also, we have some pretty firm indications that direct seeding can be done successfully and that, by appropriate measures for exposing mineral soil, natural regeneration of pitch pine can be brought about where a seed source is present.

COASTAL OAK-PINE RESEARCH CENTER

Area Served

The area served by the Coastal Oak-Pine Research Center (fig. 1) includes Cape Cod and west-central Massachusetts, Rhode Island, Connecticut, southeastern New York, New Jersey, Delaware, and eastern Maryland (chiefly the Eastern Shore section). The total land area is 16.5 million acres. Topographically, as the name implies, most of the area is low-lying coastal plain. The highlands of the

Kittatinny Mountains in New Jersey, the Ramapo Mountains and Hudson Highlands of New York, and the mountains of northwestern Connecticut--an extension of the Berkshires--are also included in the region.

Forested land occupies about 8.8 million acres or 53 percent of the total area (table 1). Only 3 percent of this forested area is noncommercial. Major forest-type groups are loblolly and pond pines with hardwoods; pitch and shortleaf pines and hardwoods; mixed oaks; oak and yellow-poplar; and Atlantic white-cedar and swamp hardwoods. Of the total commercial forest land, softwood types cover 3.2 million acres and hardwood types 5.3 million acres (table 3). About 94 percent of the commercial forest land is privately owned, of which 26 percent is in farm-forest holdings. State, county, and municipal ownerships amount to 5 percent of the total commercial forest land; Federal ownership 1 percent.

The area contains the most densely populated metropolitan area in the United States. In 1950 the major metropolitan areas in the Research Center territory had a population of 18.5 million persons, about 12 percent of the U. S. total.

Over the 300 years since settlement, the forests of this region have borne repeated and heavy overcutting and damage by wild fires. As a result many stands have been depleted of desirable species or have even changed into brush fields. As the result of urbanization and industrialization much of the commercial forest land is held as estates and for the expansion of cities, suburbs, and factories. This is true of southern New England, southeastern New York, northern New Jersey, and the lower Delaware Valley. Only farm woodlands and the extensive forests of pine-oak in southern New Jersey, Delaware, and the Eastern Shore of Maryland seem likely to remain in forest production during future years. We are concerned chiefly with the problems of these latter forests.

The headquarters of this Research Center are in Upper Darby, Pennsylvania.

Problems

1 The conversion of depleted sprout oak forests to more desirable pines, especially on relatively infertile sandy soils, would greatly increase forest production. To make this feasible, however, several steps must be worked out. Effective but inexpensive methods of seedbed preparation must be devised to favor pines and discourage hardwoods. Methods must be selected for continuing the control of hardwoods such as oak seedlings, which infiltrate pine stands, and oak sprouts from trees cut to release young pines. The use of prescribed burning, chemicals, and other methods must be tested.

2 Methods of protecting coastal-plain forests from destructive wild fires must be devised. Reduction of fuel accumulations by prescribed burning during low-hazard periods gives promise of decreasing the incidence of uncontrollable crown fires. The problem demands continuing research.

3 In the upland hardwoods region of Connecticut, northern New Jersey, and the Delaware Valley a major job ahead is to develop methods of stand improvement and harvest cutting; to maintain or improve the growth rate and stand quality; and to reproduce desirable species. Swamp hardwoods on poorly drained soils require similar studies. Present practices give haphazard and erratic results, usually bad.

4 A problem of minor size so far as acreage is concerned but of importance because of the value of the tree species is to determine the best management of Atlantic white-cedar. As with the pines, low-value hardwoods invade and replace the white-cedar under current cutting practices. The cedar reaches its best development in dense pure stands; so hardwood-control methods must be very effective despite adverse conditions such as swampy ground, sprouting, abundant seed source, etc.

5 In the southern New England portion of the area there is a large acreage of young sprout oak forest in private ownership and subject to taxation at values higher than are justified by the land's value for forest production. The owners want to know how the forest can be managed so as to carry as much of this load as possible. In northern New Jersey the situation is similar but perhaps not so acute.

6 On the Eastern Shore of Maryland loblolly is the characteristic pine; it commonly occurs as pure stands on old fields. Typically gums and other hardwoods invade these stands and occupy the land when the pine is cut. Most owners want pine, not hardwoods; and the question is what measures during the life of pine stands and at their harvest will arrest and reverse the natural trend to hardwoods.

7 Of equal importance with the forest problems listed is the over-all problem of the effect of forest cover and forest-management practices on the replenishment and stability of groundwater levels. The industrial development and urban population demands from Connecticut to the lower Delaware Valley place an increasing draft on the groundwaters of the region. The problem is urgent because of future needs of rapidly expanding populations and industrial activities in this area.

Research Program

The present program is confined chiefly to the pine-hardwood types and with the problems of stand practices to secure well-stocked seedling pine regeneration. Work in other forest types has been deferred because manpower has not been available for it. Work is in progress at two experimental forests: the Lebanon Experimental Forest in New Jersey and the Eastern Shore Experimental Forest in Maryland.

Studies in progress include the use of light winter fires or mechanical equipment for hardwood control and seedbed preparation in various pine-oak types at different ages. In loblolly-pond pine stands on wetter sites, seedbed preparation by hot summer fires is being tested. In order to keep hardwoods in check, deadening by girdling and chemicals is being studied. Enclosures to determine the importance and effects of deer browsing have been established. Methods of release cutting, weeding, and thinning young pine stands are being developed. A study of pines from different geographical seed sources is in progress.

Research Results

The studies in pine-hardwood types have been under way for some years. Some highlights of results:

Light winter fires at intervals of two or more years can safely be used to prepare a seedbed favorable for pitch and shortleaf pine. When properly used, such fires do not decrease but aid the growth and value of treated stands.

Prescribed fires help to protect against wild fires, by reducing the duff and shrubby fuels. By establishing a block pattern of treated areas, wild fires are more easily controlled and do less damage.

Seedbed preparation with heavy machinery is costly and of doubtful value in favoring pines, unless done during seed years. Prescribed burns preceding shelterwood cuttings favor the establishment of advance pine seedlings so that conversion to pine may proceed regardless of pine seed years.

A hot summer fire in a loblolly pine-hardwood stand consumed duff and logging slash, killed back or eliminated most hardwoods and brush, and resulted in abundant pine reproduction following a good seed year. Much less effective in securing loblolly pine reproduction was scarifying the soil with a small fire plow or dragged stump, prior to a seed-tree cutting. A hot summer fire in a seed year also proved effective in securing abundant pitch pine seedling reproduction in a moist lowland site.

White-cedar stands may best be perpetuated by progressive clear-cuttings, proceeding a few acres at a time from east to west. Slash should be burned and sprout hard-

woods kept in check by weeding or silvicides if pure white-cedar stands are desired. The thinning of mature white-cedar stands does not greatly stimulate the growth of residual trees and opens up the canopy to invasion by seedlings of hardwood trees and shrubs. Reduced yields at time of final cutting and presence of the hardwood understory as a result of thinning make this practice inadvisable. Such stands are difficult to reproduce to young growth of pure white-cedar.

DELAWARE BASIN RESEARCH CENTER

Area Served

The area served by this Research Center consists of the watershed of the Delaware River. The total area, excluding Delaware Bay, is 12,765 square miles. Of this total, 2,362 square miles are in New York State, 2,969 in New Jersey, 6,422 in Pennsylvania, and 1,004 in Delaware.

The watershed may be considered in three sections: Upland, Piedmont, and Coastal Plain. These sections occupy, respectively, 46, 31, and 23 percent of the total drainage area. The Upland section is the upper part of the watershed north of and including the Appalachian front. Much of this area is characterized by rugged topography with long steep slopes. The Piedmont section is that portion of the watershed south of the Appalachian front and north of a northeast-southwest line running above Wilmington, Philadelphia, and Trenton. The remainder of the watershed is Coastal Plain.

The soils in the northern part of the watershed are derived from glacial till and outwash material largely from the local acidic sandstones and shale. Much of the Upland is poorly or imperfectly drained. The steeper slopes usually have well-drained but shallow soils. Nearly all of the glaciated areas are gravelly or flaggy and the steep slopes are frequently stony. The soils of the Piedmont include moderately deep to shallow series with low infiltration rates, developed on shale and sandstone, and deep soils with higher infiltration rates developed on schist, gneiss, and quartzite. In the Coastal Plain area the soils nearest the Piedmont line are mostly well drained but include small areas with slowly permeable subsoil and retarded drainage. Farther east and south, the soils are sandy, well to excessively drained, and droughty.

The Delaware River and its tributaries provide the water supply in whole or part for some 15 million people in New York, New Jersey, Pennsylvania, and Delaware. The lower

part of the Delaware Valley is probably the most rapidly growing industrial section in the country.

The Pocono Mountains of Pennsylvania, the Catskill Mountains of New York, and the mountain area in northwestern New Jersey furnish recreational opportunities to many thousands of people from the densely populated Middle Atlantic States.

The headquarters for the Delaware Basin Research Center are in Bethlehem, Pennsylvania.

Problems

1 One of the most important problems in watershed management in this area is to improve the characteristics of streamflow by bringing about a reduction in high-water flows and an increase in the low-water flows. It has been estimated that 50 percent of the total annual water yield of the Delaware comes off in only 30 percent of the time. This is indicative of the undesirable characters of streamflow. Although precipitation is well distributed throughout the year, water yields are in the nature of high flows during the late summer and spring, often reaching flood proportions, particularly in the tributaries, followed by very low flows during the late summer and fall. While yields vary greatly during the year, most water uses are maintained at a high level throughout the year, with some uses increasing greatly during the summer and fall.

2 Another challenging problem is how to carry on the many different uses of the land without jeopardizing the water resource. Water is probably the most important natural resource of the Delaware River Basin. A number of other resources are of great importance, but their utilization or exploitation may result in damage to water values. Forests cover 45 percent of the total watershed area. These forests, because of their proximity to markets that use large quantities of forest products, are important to the Middle Atlantic States. Destructive methods of harvesting these forest products have impaired the hydrologic characteristics of the forest lands. Thus, watershed values have been damaged. It is important to know how these forest lands must be managed to obtain the best yield of forest products and still protect the water resource.

3 The upper part of the watershed is an important milk-producing area. Heavy pasturing of dairy cows on relatively steep slopes has produced conditions conducive to rapid runoff and erosion. Milk production is vital to a great number of people, but to protect watershed values it is necessary that some land use be changed from pasture to forest--besides getting better pasture management on other

areas. How to obtain the best integration of pasture use with full protection of the water resource is of importance.

4 With the tremendous increase in recreational use of the Upland parts of the Delaware Basin it is important to know how this use affects other uses--and vice versa. The mountain country of this watershed lies reasonably close to millions of people in metropolitan areas of three states. It is imperative that recreational opportunities be maintained, but it should also be determined just how this use affects other uses, particularly watershed protection.

Research Program

A number of studies have been started by this Research Center:

1 Studies intended to determine the best method of converting unproductive scrub-oak covered areas to commercially valuable timber stands at a reasonable cost. These studies, centered largely on the Delaware-Lehigh Experimental Forest in Monroe County, Pennsylvania, are being carried on with the Anthracite Research Center and the Pennsylvania Department of Forests and Waters. They have been described under the section covering the work of the Anthracite Research Center.

2 Hydrologic characteristics of a scrub-oak watershed. On the Delaware-Lehigh Experimental Forest measurements are being made of all forms of disposition of precipitated water upon a watershed covered largely with scrub oak.

3 Effect of water yields, both quantity and quality, of converting vegetative cover from scrub oak to high forest. On the Delaware-Lehigh Experimental Forest, after the hydrologic characteristics of a scrub oak watershed have been determined, steps will be taken to convert the cover on the watershed to a high forest of desirable species as soon as possible. Measurements will be made to determine the effect of such conversion upon the hydrologic characteristics of the area.

4 Effect of certain methods of managing northern hardwoods upon water yields. This study, which has been started on the Pocono Experimental Forest, is intended to determine the effect upon water yields of managing a northern hardwood stand with good cutting practices. This study is being carried on with the Anthracite Research Center.

5 Soil freezing studies. Field observations have been made on a number of plots of the type of soil freezing

that occurs during the winter under a variety of land uses and forest conditions. Studies are now being started in the laboratory to determine under controlled conditions the basic factors governing the type of soil freezing that will occur. Measurements will also be made to determine the relative permeability of the various types of frozen soil.

Research Results

Results of the scrub oak conversion studies have been given in the section on the Anthracite Research Center. Here it may be added that sufficient information is now available to serve as a guide in preparing plans for converting the vegetation on the experimental watershed.

Measurements of rainfall interception by vegetation show that it is directly related to the size of individual storms. Rainfall interception by a dense mixed stand of hardwoods and conifers with an understory of rhododendron is some three times that found for a scrub oak cover. Evapo-transpiration losses were found to be related to daily average saturation deficits. These relationships provide a method of measuring the effect of changes in vegetative cover upon hydrologic factors.

Observation of soil freezing has brought out very strikingly the differences in frost under different forest conditions and different land uses. Open lands freeze readily to form a dense, hard, impermeable frost. Forested lands freeze much less rapidly and have in general a more permeable type of frost. Coniferous forests tend to have more concrete frost than do hardwood forests under comparable climatic conditions. Any disturbance of the forest floor, such as that due to logging, livestock grazing, or fire, results in a pronounced increase in concrete frost during the winter months.

MOUNTAIN STATE RESEARCH CENTER

Area Served

This Research Center serves a problem area of approximately 23½ million acres in the mountainous portions of Kentucky, West Virginia, Maryland, and Pennsylvania. Soils are generally shallow; they are derived from unglaciated sandstones and shales. As a result of steep topography, shallow soils and abundant rainfall, forest is the dominant use of land in the area. Many important interstate streams have their headwaters in this area: the Potomac, Monongahela, the Kanawha, and other tributaries to the Ohio River.

Forests cover about two-thirds of the land area. In addition, about 1½ million acres of open land should probably be allowed to revert to forest; these are largely submarginal crop land, wornout pasture land on steep and eroded slopes, and strip-mined areas. Over 92 percent of the commercial forest area is occupied by hardwoods, largely the oak types, yellow-poplar, and northern hardwoods (sugar maple-beech-yellow birch). Approximately 91 percent of the commercial forest land is in private ownership, of which about one-third is in farm forest.

Headquarters for this Research Center are in Elkins, West Virginia.

Problems

A number of problems must be solved before the benefits of managing these forest lands can be fully realized.

1 How to develop logging methods that incorporate good forest practices and still provide reasonable assurance of a net operating return. This mountainous terrain presents a particularly difficult logging chance. Clear-cutting the most accessible areas and high-grading the others seem to most lumbermen to offer the greatest promise for financial gain. At the present time, sustained-yield management is regarded as a financial hazard few loggers are willing to assume. Forestry will advance in this mountain area only to the extent that desirable practices are shown to pay.

2 How to locate, construct, and maintain logging skid and haul roads such that watershed values will be protected and yet costs will not be so excessive as to make the logging operation unprofitable. At the present time, skid and haul roads are in general poorly constructed. Steep grades are the rule. Much of the timber is skidded and trucked in the stream channels. These practices result in erosion and damage to watershed values. They are also expensive and increase logging costs. Since these roads usually wash out because no provision is made to protect them, the total investment is lost, and the roads must be replaced at the time of the next cut.

3 What forest practices will allow periodic harvesting of timber resources and will still provide for full watershed protection? As the forests were abused, so was the water resource. The ability of forested watersheds to regulate the flow of water has been impaired. Extensive over-cutting, burning, and improper logging practices depleted the forest resource. They also reduced the capacity of the forest to protect water values. Streamflow has become

quite erratic: it varies from periods of high flow--often of full flood proportions--to very low flows that threaten serious shortages for industries and communities. The capacity of these forested lands to produce well-regulated yields of water must be built up and maintained through judicious management of the timber stands.

4 What type and intensity of cutting must be applied to convert the present understocked, poor-quality stands to fully stocked vigorous stands of good quality and desirable species? As a result of poor cutting practices in the past, the quality and quantity of timber produced and harvested has declined. Many stands are of poor stocking with a large volume in culls and undesirable species. In order to realize the full potential of timber production from this area a rehabilitation job must be undertaken.

5 What methods of cutting will insure a sustained supply of both bulk products and high-quality lumber? Approximately 25 percent of all timber cut in this coal-producing area goes into the mines. Yet this area produces some of the finest quality hardwoods for veneer, flooring, high-grade lumber, and specialty products. If the destructive cutting of young stands for mine timbers and other bulk products is to be stopped a way must be found to manage the stands so that adequate supplies of both bulk products and quality lumber may be realized.

6 A number of problems arise in connection with the reforestation of idle and abandoned open land, cut-over forest areas, and strip-mine spoil banks. Unwise agricultural clearing, heavy logging followed by burning, and extensive strip-mining have created a sizable planting job. These areas are unproductive. They contribute nothing to local economy. They are also critical watershed problems.

7 How can the deer herd be managed to meet the needs of the hunter without destroying forest reproduction? The deer population is increasing. One method of controlling population is by means of hunting. Another is through manipulation of environment which, in this area, is primarily the millions of acres of forest growth. Timber management of necessity becomes a tool of the wildlife manager. He must know what effect different methods of cutting will have on the deer population and what effect the deer population has on the forest.

8 How to manage, harvest, and sell the timber crop from farm woodlots so that the farmer will realize a sustained income from such lands is a big problem. Farmers own

about 33 percent of the forest land in the area. If properly managed, these woodlands could produce a regular income for the farmer and a large volume of timber for industry. Yet in most places these farm forests are not managed.

Research Program

The research program is designed to find solutions to problems that hinder the production of the maximum quality and quantity of both timber and water. This can best be accomplished by an integrated research program in which major problems are studied under actual commercial field conditions. These comprehensive and coordinated studies are necessary to determine the economic, silvicultural, and hydrologic feasibility of managing and logging mountain hardwoods.

By keeping records of costs and returns of different intensities of management, the economic and silvicultural feasibility of managing and logging mountain hardwoods will be determined. In addition, the effect of different practices on water quality and quantity will be studied. In that way the composite effect of a level of management will be available for both timber production and water regulation. The present research program is centered largely on the Fernow Experimental Forest near Parsons, West Virginia. Here long-range integrated studies now under way are:

1 Studies to determine costs and returns under four levels of management.

2 Studies to test different levels of management for the production of bulk products.

3 Studies to test equipment and methods of management applicable for use on farm woods.

4 Studies to test the hydrologic effect, on a watershed basis, of four levels of forest management.

In addition to these long-term studies, a number of special studies pertaining to both timber and watershed management have been undertaken, largely on the Fernow Experimental Forest, intended to determine relationships between individual factors. These studies include:

1 Studies to evaluate the economic phases of various steps in logging.

2 Studies to evaluate the hydrologic effect of different logging and skidding methods.

3 Studies to convert present understocked stands to productive ones.

4 Studies to determine efficient methods of revegetating spoil banks, abandoned pastures, and cut and burned spruce land.

5 Studies to determine hydrologic effect of revegetation of skid roads.

6 Studies to determine rates of growth of native tree species and factors that affect growth.

7 Studies to determine interrelations of game populations and cutting practices.

Research Results

Tentative results from the integrated-management studies indicate that the cost of logging need no longer discourage good forest management. The solution to this problem lies in: (1) Planning and constructing an efficient skid-road system in advance of logging, and (2) adapting mechanized equipment to mountainous terrain and developing techniques for its most efficient use.

Skid road erosion can be reduced by: limiting the gradient, constructing cheap water diversions, maintenance during logging, and protection during periods of idleness. The mileage of skid roads required can be greatly reduced by careful planning. Less mileage at low gradients means less erosion as well as lower construction and maintenance costs.

Evidence is accumulating that integrated timber and watershed management is economically and silviculturally feasible even in this difficult logging area.

Reforestation of strip-mined land and burned-over spruce lands has been found to be practical.

Farm-woodlot management may be carried on at a profit and still improve and maintain the quality of the stand.

PENOBSCOT RESEARCH CENTER

Area Served

The area served by the Penobscot Research Center is more completely dominated by forests and forest industry than any of the other research areas of the Northeast. In the spruce-fir area (fig. 1), 88 percent of the land is commercial forest land (table 1); but of this commercial forest

land only 10 percent is in farm forests and an almost negligible amount is in public ownership (table 2). In none of the other areas are large industrial holdings so common, nor do they attain quite such large size.

Other features that add to the distinctiveness of this area are: the prevalence and dominance of spruce-fir and spruce-fir-hardwood types; substantial acreages of northern hardwoods and white pine mingled with the two more abundant types; glaciated topography with a wide range of soils irregularly arranged; large areas privately owned but unsettled, undeveloped, and lacking roads and local government; the extent to which the pulp and paper industry dominates the forestry picture; the tradition that removal of all softwoods is the mark of a competent logger; the preoccupation of forest owners and industry with spruce, fir, and pine and the recentness of interest in hardwoods; how little is known about the forest resource, considering its importance to the regional economy; and finally birch dieback and the threat of the spruce budworm. Taken together these features give the area its character and its problems.

Headquarters for the Penobscot Research Center are in Bangor, Maine.

Problems

1 There is need to extend to Maine the nationwide forest survey to determine the extent and magnitude of the forest resource, its growth and the demands upon it. Periodic past inventories by owners have been uncoordinated, incomplete for the area as a whole, and usually directed toward softwoods only. Generally the results have not been available to any one but the landowner. Information of the sort obtained by the forest survey would help in adjusting forest industry to the resource during the protracted period of conversion from unmanaged to managed forests.

2 How to recognize and classify forest lands into productivity classes is a problem to be solved as a step toward improved forest management. With such vast areas of forest land available, intensity of management should be geared directly to site productivity.

3 Further information about insects and diseases, the losses they cause, and their relation to forest management might lead to better practices. It has been estimated that insects and disease in Maine alone destroy 80 million cubic feet of wood yearly. It is a well-established principle that good forest management can be effective in reducing such damage. Details of applying this principle for birch dieback, beech scale, and the still-threatening spruce budworm should be worked out and demonstrated.

4 What are the ecological, silvical, and silvicultural characteristics of minor components of the stands and what are the potential markets for them? Paper birch, white spruce, and northern white-cedar are examples of the species that might contribute much to forest productivity if we knew more about them.

5 What to do with, or to, the vast quantities of hardwoods found mixed with softwoods and in pure hardwood stands is a vexing problem. They have not been utilized because they don't float, and roads to haul them over have not been available. Overmaturity, decadence, and loss have been common--and can be expected to continue. Markets for lumber and veneer logs of maple and birch are available for accessible stands but demand for lower quality hardwood is infinitesimal in relation to supply.

6 How to make good management effective and highly profitable to the owner of small forest tracts? Some 3½ million acres of commercial forest are held by farm and nonfarm owners in small woodlots. And on the average this is the worst managed and least productive class of forest property despite accessibility, nearness to markets, and generally good site quality.

7 What cutting practices are appropriate for mature stands under various circumstances? Until recently an abundance of wood and the relative inaccessibility of stands best adapted to management have caused better cutting practices to be considered unattractive economically. But evidence is showing that many large owners are only waiting for experimental proof of the best techniques and reasonable assurance that they can be made to pay, to set good forestry programs in motion. Such programs are most likely to be begun at the time of a harvest cutting, so information is needed as to costs and returns associated with various levels and kinds of cutting.

8 What methods are practical and economically feasible for reclaiming lands invaded by ferns and brush? Some 2½ million acres have been converted from tree cover to fern, raspberry, hazel, or alder by destructive cutting, fire, or both. Without help it may take 50 to 75 years for tree species to occupy these areas again. Artificial restoration or management measures to shorten this time will be attractive to owners only to the extent that they are economically or financially advantageous.

Research Program

The present program of the Center, while aimed at the broad problems of the area, reflects in its details the earlier work of the Station in the spruce-fir type. Research in spruce-fir silviculture conducted by the Station for nearly 30 years has established a firm foundation for the current research. The studies now under way include:

1 Study of costs and returns from different levels of management and cutting practices.

2 Evaluation of intensive management practices applied to good and poor woodlots, with emphasis on the problems of farm owners.

3 Study of topography-geology-soil-site quality relationships for spruce and fir.

4 Development of a tree-classification system for spruce and fir, based on crown characteristics and directed toward improved tree selection in cutting.

5 An area-wide study of the growth of unmanaged stands under various conditions; this study is in cooperation with large landowners.

6 A study of the extent of spruce and fir breakage due to wind, as related to method of cutting and other factors.

7 A study of optimum stocking and stand structure for various product objectives and species compositions.

8 Evaluation of tree and stand characteristics as related to ability to withstand attack by the spruce budworm, and of silvicultural measures to increase such ability, chiefly by stimulating growth rates.

9 A study to determine economical ways and means of restoring nonproductive cutover and burned land to profitable growth of desirable species.

Some of the above projects are under way on the Penobscot Experimental Forest near Bangor, Maine. This forest was purchased for research purposes and made available to the Station through the cooperation of nine large landowners. Other projects are pursued off the experimental forest in cooperation with individual owners and companies. The regional growth study, budworm-resistance study, and the site-quality study are examples of the latter group. The Gale

River Experimental Forest near Twin Mountain, New Hampshire, is attached to the Penobscot Research Center but at present is inactive.

Research Results

Since the Penobscot Research Center was formally set up, the studies have yielded the following results.

Data and techniques developed in the budworm-hazard-evaluation study permit operators to plan operations so that spruce-fir stands can be cut in order of their susceptibility to damage.

Spruce and fir trees can be classified as to growth rate from crown characteristics, thus enabling better selection of trees to be retained when stands are marked for cutting.

Wind damage to spruce and fir was found to be minor following partial cutting; this is in contrast to long-standing opinion in the territory.

Early results from the study of woodlot management indicate that intensive improvement measures can be made to pay the owner a reasonable hourly wage.

Once trees start to die after budworm defoliation, mortality increases rapidly and salvage must be undertaken rather promptly.

Time-study data taken on the cuttings to increase resistance to budworm attack yielded tables of production rates for pulpwood that can be used in planning operations.

Tables have been prepared showing time required to prune white pine and spruce trees as affected by height of pruning and the size and number of branches. White pine is much cheaper to prune than spruce.

VIRGINIA PINE-HARDWOOD RESEARCH CENTER

Area Served

Southeastern Pennsylvania, central Maryland, and the northern piedmont of Virginia comprise the area served by this Research Center. Here conditions seem favorable for the practice of forestry, yet the level of forest management being practiced is generally low.

Topography is generally gentle to rolling and presents no obstacle to logging or management operations. Climate is favorable for practically year-round woods work. The network of good roads and railroads is dense. Markets are close and reasonably stable. Good species are present in considerable variety.

The ownership pattern is dominated by small tracts and a correspondingly large numbers of owners. Large industrially owned tracts are not common. The public ownership includes areas held for military and park purposes rather than for forest production (table 2).

Virginia pine is the characteristic conifer of the area. It occurs, typically, on land abandoned from cultivation, and on the poorer, thinner soils of dry ridge tops. Early growth of even-aged stands is usually good but the species is short-lived. It is in demand for pulpwood and the lumber goes to market along with other southern pines.

Hardwoods are a nuisance on the poorer sites; they invade pine stands yet never attain good quality. On better sites and soils, however, they do well. Oaks are most at home on the drier sites, but on lower slopes and bottoms cove hardwoods are common. The wide range in site quality, however, permits many species to become established where they do poorly and hence become unwanted growing stock.

Headquarters of the Virginia Pine-Hardwood Research Center are at the Beltsville Experimental Forest on the Agricultural Research Center near Beltsville, Maryland.

Problems

1 Comparatively little research has been done on Virginia pine. Its form and growth habits earned it the name "scrub pine" and as such it drew little interest. Consequently a considerable mass of technical information is needed on its ecology, requirements, responses, and management as a basis for improved practices. Examples of the elementary information needed are: Identification of the site conditions where Virginia pine can easily be maintained in competition with hardwoods and where it cannot. This may require deeper study of the requirements and tolerances of the species as to moisture, nutrients, soil depth, microclimate, or other elements. Information is needed on seed production and dispersal; seedbed requirements and tolerances; stand structure for optimum growth, including density and growing-space requirements during the life of stands; windfirmness and factors affecting it; and means of overcoming the inherent limbiness, crook, and sweep of the species.

2 Pending accumulation of information on the above, empirical silvicultural studies are needed to test promising leads suggested by work with other pines.

3 With the normal succession to hardwoods on most sites a ubiquitous problem is (1) where, and (2) how to control the hardwoods and thus arrest the natural trend. Alterna-

tives would seem to include increasing hardwood utilization through new uses or cheaper delivery to present markets, or developing cheap and effective direct-control measures.

4 How to manage the hardwood forest is a problem more complex than the problem with pine. Many species are present, each with its own requirements and responses. A number have been studied more or less thoroughly elsewhere and the earlier results need only checking for local application. For others, basic information is required similar to that needed for Virginia pine.

Research Program

Current work of the Research Center is concerned chiefly with Virginia pine. At present the resources available to the Center do not permit work on hardwoods except as incidental to the pine studies. The program does, however, include some specialized work in forest genetics on the Beltsville Experimental Forest, which is directed toward regional problems rather than those of the Center's area alone. The present program includes studies on:

1 Seeding habits and seedbed requirements of Virginia pine and the use of fire and machinery for seedbed preparation.

2 Mensurational studies of form and volume of Virginia pine.

3 Logging methods and equipment to reduce costs.

4 Wood-chip production and use as a possible outlet for small pine and hardwood material.

5 Heart rot in Virginia pine.

6 Thinning and spacing of Virginia pine.

7 Harvest cuttings to favor pine reproduction.

8 Large-scale tests of various management programs in a search for those that are biologically and financially sound.

9 Application of intensive forest-management practices to farm forests to determine and demonstrate the feasibility of better forestry.

10 Screening more than 200 hybrid poplars, and other trees developed by the Station's forest genetics project for

disease and insect resistance, growth rate, and adaptability to soils and climate of the Beltsville Experimental Forest.

Although much of the work is concentrated on the experimental forest, state organizations and private companies are cooperating on a number of the studies.

Research Results

The current research program was adopted in 1951 when the Research Center was established in its present form. Even so, some results and preliminary conclusions have been obtained.

No substitute has been found yet for plowing and cultivation as planting-site preparation and first-year care for hybrid-poplar plantations. The best of the hybrids from the Maine seedling plantation show very wide range in growth rates at Beltsville.

Virginia pine crop trees should be selected at about 10 years of age, pruned to 8 feet, and released from competition of surrounding trees to maintain fast growth of clear wood. About 7 years later further pruning and release will be required. Seed crops of Virginia pine can be forecast a year in advance. A local volume table has been developed for Virginia pine for use on the experimental forest. Formulas and tables for estimating diameters at breast height from stump diameters have been derived.

Chips and wood fragments suitable for cattle bedding and poultry litter can be made from pine thinnings at a reasonable cost per ton.

WHITE PINE-HARDWOOD RESEARCH CENTER

Area Served

As the hyphenated name indicates, this Research Center serves an area characterized by two major forest types. It includes parts of five states (fig. 1). Thirteen of the 20 million acres in the problem area are commercial forest land and about ½ million are noncommercial (table 1). The 3 million acres of white pine and 4 million of northern hardwoods give the problem area its name (table 3). They occur in varying mixtures, and with other minor types.

Each of the major types occupies a characteristic set of sites and has its own technical and economic features. The areas predominantly in northern hardwoods are rolling to mountainous. The soils are derived from igneous rocks and are medium in texture. The rough terrain and normally deep

snow cover make logging difficult and expensive. White pine occupies the more level areas. Here soils are generally sandy. Agriculture is declining, and abandoned land is generally captured by pure stands of pine. Hardwoods less valuable than the pine invade these stands and tend to take over the area when pine is cut.

Ownership of the forest land is shown in table 2. The area of publicly owned land is in the critical headwaters areas. Privately owned land is held in thousands of small tracts by farmers and other individuals. There are a number of large corporate holdings also.

Although this is important timber-producing country, water values are also exceedingly high. Requirements for recreation, downstream industry, and domestic use are large and increasing. The major streams that originate in this area flow through several states; so headwaters conditions have far-reaching effects.

Markets are generally good, partly because of the intrinsic quality of the principal species and partly because of proximity to populous industrial areas. White pine has always been eagerly sought. High-quality logs of yellow birch and maple also find a ready market, as do ash and white birch bolts. Beech is less salable and generally is considered low-value material. Although pulp mills and sawmills provide the bulk of the markets, veneer, turning, and specialty plants add diversity to the markets.

The entire region is heavily used for recreation, chiefly because of its climate, its mountains, and its lakes. Aesthetic limitations on forest and watershed management are perhaps not so stringent as in some other areas, but still they must be considered.

Headquarters for the White Pine-Hardwood Research Center is at Laconia, New Hampshire. Work in the white pine type is concentrated chiefly on the Massabesic Experimental Forest in Maine; work on hardwoods at the Bartlett Experimental Forest in New Hampshire and the Hopkins Memorial Experimental Forest at Williamstown, Mass.

Problems

Outstanding problems of the white pine type include:

1 Identification of sites best adapted to maintaining white pine. The species often occurs as a temporary species following agricultural abandonment, windthrow, or fire. On some soils and under some conditions it has been extremely difficult and costly to maintain the pine against hardwood invasion. Elsewhere management for white pine appears to be relatively easy. The job is to describe the site conditions, chiefly soil, where white pine is the best

species to be grown.

2 Cheap and effective methods for discouraging hardwood and encouraging pine (except on strong hardwood sites) are needed, especially during the reproduction and sapling stages in the life of stands.

3 What management measures can be used to rehabilitate and reclaim for pine the areas with growing stock depleted by bad cutting or fire? The relentless demand for pine has led to too heavy and too early cutting of even-aged stands and to steady decline in quantity and quality of growing stock in the region. Occasional bad fire years have created truly large areas of devastation.

4 What intensities of management are financially feasible for white pine? What silvicultural systems and cultural measures pay their way and can be combined into profitable programs of management? White pine lands characteristically are privately owned and the answers to these questions will determine how they will be handled.

5 How to control the white pine weevil is, without question, the greatest protection problem in white pine today. Until it is solved, the white pine region cannot attain full productivity.

In the northern hardwoods portion of the Center's territory the outstanding problems are:

1 How to obtain improvement in harvest-cutting methods? Part of the solution seems to depend on devising better equipment, organization, and transport methods for logging so as to reduce costs and provide a margin to offset the supposed higher cost of good practices. Further evaluation of promising methods and of various levels of growing stock and cutting cycles is also needed for managerial decisions.

2 Is good timber management also good watershed management? The importance of water is such that the cutting methods, logging practices, truck-road standards, and even product objectives desirable for timber production must be evaluated and if necessary modified in the interest of watershed management.

3 What forest-management techniques constitute practical methods to control outbreaks of disease and insects and to minimize losses? Birch dieback and beech scale-nectria are now the most important control problems. Losses are very heavy because of them and may increase.

4 What steps can be taken to restore desirable species composition, stand structure, and tree quality in depleted hardwood stands? Abandoned agricultural lands can be considered an extreme of the condition. Technical aspects concern species selection, cultural measures to improve composition and tree form, and special equipment for the jobs. Economic aspects concern comparative costs and effectiveness of treatments and the economics of planting versus natural regeneration.

5 As in almost every other part of the Station's territory there is an urgent need to develop and demonstrate the forest-management programs that will be productive and profitable on small forest tracts. The regional economy can ill afford the present low level of production on a third or more of its forest area.

6 Development and field selection of superior planting stock. In the future practice of intensive management there will be a place for fast-growing disease- and insect-resistant stock of certain species such as birch, ash, and maple. It is not too early now to select, breed, and test improved trees in anticipation of that demand.

Research Program

The present program of the White Pine-Hardwood Research Center is directed toward solution of the broad problems outlined above. It is made up of the following:

1 Studies of: the silvics and regeneration requirements of the birches and white pine; rehabilitation of severely burned pine lands in Maine, and of lands usurped by spiraea brush; thinning and weeding in hardwood stands; harvest-cutting methods in white pine and northern hardwoods that assure regeneration with desired species, and, in northern hardwoods, of cutting methods and stand conditions that limit the spread, reduce damage, or help control of birch dieback and the beech scale-nectria complex.

2 The development and selection of superior strains of trees for planting is directed chiefly toward sugar maple and poplars. Less attention is being given to the ashes. A corollary study seeks cheap and effective methods for planting the hardwoods. Present methods require site preparation and cultivation.

3 Test and demonstration of management programs adapted to small forest properties.

4 Large-scale, long-term experiments in both white pine and northern hardwoods to evaluate, biologically and economically, management programs embodying different product objectives, silvicultural systems, growing-stock volumes and structures, cutting cycles, and cultural measures.

The absence of any studies in watershed management should be corrected as soon as funds can be obtained for the work.

Research Results

Recent results of the research at the White Pine-Hardwood Research Center include further confirmation of some earlier preliminary conclusions and some new information. For northern hardwoods they include:

The single-tree selection system is applicable in second-growth as well as in old-growth stands.

Moderate growing stock appears to offer advantages in growth, whether expressed in actual wood volume or as a percentage yield.

Where the overstory has little value and reproduction is desired, patch clear-cutting gives good results. Size of patch affects composition of the reproduction.

A well-established understory of desired species gives assurance of satisfactory regeneration following clear-cutting of all-aged stands.

Removal of worthless stems, particularly wolf trees or potential wolf trees, is essential to full productivity of stands.

Post-logging decadence of birch (symptoms identical to birch dieback in uncut stands) can be minimized by limiting cutting to not more than 40 percent of stand volume.

Fire is not required for successful regeneration of paper birch from seed.

Preliminary results indicate the feasibility of making light, very frequent cuts on small forest properties.

FOREST GENETICS

Unlike the somewhat localized areas served by the research centers, the forest genetics area of interest is region-wide. It covers all aspects of the genetic improvement of the important forest trees in the 10 forest types in this region.

Headquarters for the forest genetics work are at the Morris Arboretum of the University of Pennsylvania, in Philadelphia.

Problems

Expanding interest in more intensive forestry in this region is building up a rapidly increasing demand for inherently better trees for planting. In the Northeastern region there are more than 9 million acres of poorly stocked and denuded forest land on which some degree of reforestation is needed to bring the land into full productivity. To meet this demand and to stimulate increased reforestation we must select or produce trees that are inherently better than the native species in rapidity of growth, resistance to disease and insects, timber form, wood quality, or specific qualities such as a higher percentage of sugar in the sap of the hard maple.

There are approximately 62 million acres of commercial forest land in this region that are at present considered to be adequately stocked. Much of this forest land will probably be managed under some system of natural regeneration. It is essential that the genetical quality of these naturally regenerated stands be maintained without degradation, and that wherever possible their inherent quality be improved. This will be possible only through the application of genetical mass-selection. For the application of such mass-selection methods to forest practice we need exact information on the mode of inheritance and criteria for selecting the inherently best trees in the forest stand.

Research Program

Hybrid poplar.--Field testing of 250 poplar hybrids selected on the basis of their 18- to 20-year growth rate, disease and insect resistance, and hardiness in the seedling plantation in western Maine.

Breeding.--Controlled breeding between races and species of ash, maple, yellow-poplar, spruce, and pine to determine crossability patterns and growth qualities (hybrid vigor, disease resistance, form, etc.) of the progenies.

Racial variation.--Study of the racial variation in white ash to determine the best races for the Northeastern region.

Individual tree variation.--Studies on genetic variation in the sugar content of sugar maple sap, and weevil resistance in white pine.

Exotics.--Survey of plantations or individual trees of exotic species to determine the most promising for this region.

Research Results

Our findings can be summarized briefly and most effectively by genera.

Hybrid poplars.--On the best sites and with proper culture, we have found that the best hybrids can produce veneer logs in 16 to 20 years. Our clonal tests of 250 hybrids have shown that no single clone is equally good in growth rate and disease resistance throughout the entire region. We now have selected groups of 50 to 75 clones that have shown up best for the northern and southern climatic zones in the Northeast.

Ash.--We have been able to cross only very closely related species. This lack of crossability and the poor performance of most exotics limits the possibility of species hybridization. Our racial tests have shown that selection and crossing within native species offers considerable promise. In both white and green ash we have evidence that individual tree selection could yield improved varieties. There are greater differences between geographic races. Instead of the northern race we can now prescribe the slightly faster-growing Pennsylvania race for planting in northern Connecticut. And in place of the local race in eastern Pennsylvania we can prescribe the much faster-growing Maryland race.

Spruce.--Of 68 interspecific crosses attempted, 24 succeeded. Most of the successes involve species occupying adjacent geographic ranges. Most of the 44 failures involve widely separated species. These crossing data, together with range and taxonomic data, give a clear idea of which crosses to attempt. The hybrids are yet only a few inches tall. Since the European and some of the Japanese species do as well here as our natives, the European and Japanese X American hybrids look most promising. We have some evidence that mass-production of hybrids is practical. From one promising combination we harvested nearly 10,000 hybrid seeds as the result of a single man-day's pollination work. The general ability of the closely related neighboring species to cross suggests that much of what is considered to be racial and individual variation within species is actually the result of natural hybridization.

Pine.--Nearly all the white pine species from various parts of the world cross with each other. But our seed sets have been rather low and none of the hybrids has grown faster than eastern white pine in the Philadelphia nursery.

The story is different in the hard pines of the se-

ries Lariciones (red, Scotch, etc.). In these as in the spruces only closely related neighboring species cross with each other. American red pine has given no hybrids with other species. We have been able to get many hybrids by crossing Japanese species, Japanese with Chinese, a few by crossing European with Japanese and European with European. The Japanese red X Scotch pine and the Japanese red X Japanese black pine hybrids are now 14 years old and are taller and of as good or better form than the parent species. Statistical studies of even-aged old-field white pine stands in Maine suggest the presence of sufficient genetic variability in resistance to the weevil to anticipate the development of resistant strains.

Maple.--We have been able to cross only closely related species and now treat each important species (sugar, red, Norway) as in a group of its own. One of the crosses made within these groups A. platanoides X A. cappadocicum shows desirable growth characters. Recently we have made interracial hybrids in red and sugar maples but still have technical details to work out before continuing the work.

FOREST INSECT INVESTIGATIONS

Report from the New Haven Station of the
Division of Forest Insect Investigations,
Bureau of Entomology and Plant Quarantine,
355 Prospect Street, New Haven, Conn.

THE PROGRAM OF RESEARCH and surveys being conducted on forest insects at New Haven was continued during 1953. The principal pests involved were the spruce budworm, white pine weevil, Matsucoccus sp., balsam woolly aphid, and beech scale.

The spruce budworm outbreak in northern Maine has increased in the vicinity of Madawaska Lake to such an extent that it is planned to spray 20,000 acres next spring. Severe outbreaks of the forest tent caterpillar and gypsy moth occurred in 1953. More than 7 million acres of hardwood were affected by the forest tent caterpillar in New York State alone, and several hundred thousand acres were defoliated in Vermont. The New Haven station assisted on surveys in Vermont, where sugar bushes took the hardest beating. Defoliation by the gypsy moth was widespread with some 1½ million acres severely fed upon in New England. The heaviest defoliation occurred in Massachusetts, in the Connecticut Valley, and in adjacent towns. Tests with Endrin and Isodrin applied by airplane indicated that both of these insecticides are even more toxic to the gypsy moth than DDT.

Spruce Budworm

The annual spruce budworm reconnaissance survey in Maine showed noticeable defoliation over a total of 155,000 acres. This was a decrease from 416,000 acres in 1952, but there was a significant increase in the intensity of attack in the Madawaska Lake area. In that region some 68,000 acres showed defoliation; 5,000 heavy, 20,000 medium and 43,000 light. The rest of the defoliated area was in the Fish River Lake-Beavertail Pond region where 87,000 acres were lightly affected.

Egg-mass surveys indicated continued high populations in the Madawaska area next year, and an unexpectedly heavy deposition of egg masses in townships north, east, and south of there. Aggregate parasitization ranged from 58 to 84 percent at 8 study plots, with the lowest parasitization oc-

curring in 2 plots in the Madawaska area. It is believed that populations there have now reached a level where natural control factors will not prevent economic damage, so it is planned to treat 20,000 acres next spring with DDT applied by airplane. This will be a cooperative project between the landowners, the State of Maine, and the Federal Government; approximately one-fourth of the cost will be paid by the Federal Government. The New Haven laboratory will supply technical advice and assistance.

An egg-mass survey was made in Vermont following a large flight of spruce budworm moths at St. Johnsbury and Lyndonville. No concentration of egg masses was located.

Propagation of the western parasite, Phytodietus fumiferanae Rohw., was continued by the Maine Forest Service at Augusta, and approximately 3,300 cocoons were reared. These are in hibernation at New Haven. A colony of 65 mated females was liberated in the Beavertail Pond area.

White Pine Weevil

An intensive study has been initiated to determine the relative effect of various stand and individual tree factors on weevil populations. It is hoped that eventually 2 to 4 study blocks of pine under hardwood or under mixed pine hardwood will be established at 4 locations. One block of 4 cover-class units was established at the Harvard Forest, Petersham, Mass., this fall. In one unit the overstory will be removed, in one the overstory will be killed by girdling and poisoning but will be left standing, in one a partial release cutting will be made, and the fourth will be undisturbed.

Studies to determine the environmental factors affecting weevil hibernation were continued, and studies to determine whether small mammals feed on overwintering weevils were initiated. The latter was set up in cooperation with the Forestry Department of the University of Massachusetts and the Fish and Wildlife Service.

The Atomic Energy Commission granted permission to release "tagged" weevils in the Otsego County Reforestation area near New Lisbon, N. Y., in September; so special studies on weevil flight and movement were begun at that time. Scandium chloride containing Sc^{46} was used, and 849 weevils were treated. So far only two weevils have been found away from release trees. Movement will be followed closely in the spring.

More than 15,000 white pines in five areas in Connecticut, Rhode Island, New York, and Massachusetts were treated with the knapsack sprayer--concentrated lead arsenate spray method. Some of these were included in "thin-and-spray" experiments, to reclaim damaged stands, but only 10 treated leaders were weeviled.

Pertinent data on volume loss in standing white pine due to weevil damage are now being taken by forest survey crews in Massachusetts and Rhode Island.

Matsucoccus sp.

Matsucoccus sp. is now known to infest an area of approximately 60 square miles in Connecticut, 40 square miles on Long Island, and isolated locations in Westchester County, New York. During October and November survey crews from Connecticut and New York scouted the areas surrounding known infestations. The infested area in Connecticut has increased about 15 square miles since 1952. In New York three new infestations were found in Scarsdale and one in Yonkers. A special survey was conducted by State and Federal representatives in the natural red pine stands in the northern part of the region, but Matsucoccus sp. was not found.

Ecological studies have been continued. Special emphasis has also been given to insecticidal control measures. More than 14 different insecticides were tested. Only two showed any promise; Systox, a systemic poison, and a 2-percent oil emulsion. Early May and June applications were more effective than those applied in September, indicating that timing may be important.

Balsam Woolly Aphid

Known infestations of the balsam woolly aphid on the White Mountain National Forest appear to be building up. Six plots were examined and two new ones established. In Vermont commercial stands of balsam fir on the Green Mountain National Forest were examined in cooperation with Forest Service personnel. No area appeared to be free of infestation and in many cases there were small local outbreaks where tree mortality was serious. Eight plots were established from the Massachusetts-Vermont line north to Texas Falls near Rochester.

It is planned to release an imported predaceous fly against this pest in New Hampshire and Vermont next spring. The species is successfully established in Maine, where it spread from New Brunswick. Small collections were made in the fall of 1953, and a small colony is in hibernation at New Haven.

Beech Scale

During the past season the numbered trees on all beech scale study plots were examined and classified according to crown position, density and health of crown, and form and soundness of bole. Scale and nectria recordings were made on the study plots at Weeks Brook and Whiteface Moun-

tain. With the exception of Weeks Brook No. 4, where the insect attack has already passed its peak, the beech scale is definitely increasing on all plots. However, the insect build-up is somewhat less and incidence of new nectria infection definitely lowest on experimental cut-over plot Weeks Brook No. 1. A few more years must elapse before this trend can be appraised.

Gypsy Moth

Tests of 15 materials indicated that only 4 (Parathion, TEPP, Endrin, and Isodrin) were more toxic than DDT against the gypsy moth. Endrin and Isodrin were used to spray two 100-acre plots at Wendell, Mass. Applications were made by airplane. Four ounces of Endrin and 8 ounces of Isodrin were applied per acre in 1 gallon of kerosene. Results were quite spectacular, apparently resulting in complete extermination.

The plan for future gypsy moth work, which was approved by the Regional Coordinating Commission and the Council of State Governments, called for the establishment of study plots throughout the generally infested area. A tentative plan has been worked out which calls for 440 ¼-acre plots distributed throughout New England. Copies of the plan, together with maps showing plot locations, etc., have been sent to each State.

Surveys

In April and May the New Haven station cooperated with the Beltsville, Md., and Gulfport, Miss., stations, the U. S. Forest Service, and Crosby Lumber Company in the development and application of an appraisal and spotting survey for the southern pine beetle. In October similar work was done in cooperation with the Fort Collins station on a survey for the Black Hills beetle. Both the Mississippi and Colorado studies are reported in some detail in the 1953 Annual Progress Report of the Beltsville, Md., station.

Dissemination Of Information

During the year all members of the staff answered a number of inquiries regarding plant, forest, and household insects. Records were kept of 174 replies to "official" requests for information. In addition there were about 300 letters of inquiry, 300 telephone calls, and 76 visitors who wished special advice from S. F. Potts regarding spray apparatus, spray formulations, etc.

Members of the staff presented papers or took part in discussions at numerous meetings in 1953. These included the Rhode Island and Massachusetts Arborists Association, North-

eastern Forest Pest Control Committee, New England Section SAF (winter and summer meetings), New England Council, Northeastern Forest Research Advisory Council, Eastern Branch Meeting of the Entomological Society of America, and Northeastern Forest Tree Improvement Conference.

Publications

Dowden, P. B., and Girth, H. B.
1953. USE OF A VIRUS DISEASE TO CONTROL THE EUROPEAN PINE SAWFLY IN THE UNITED STATES. Jour. Econ. Ent. 46 (3): 525.

---------- Jaynes, H. A., and Carolin, V. M.
1953. AN ATTEMPT TO EVALUATE THE ROLE OF BIRDS IN A SPRUCE BUDWORM OUTBREAK IN MAINE. Jour. Econ. Ent. 46 (2): 307.

Potts, S. F., Spencer, R. A., and Friend, R. B.
1953. TESTS OF A LIGHT-WEIGHT MIST BLOWER FOR ROW CROPS, SMALL TREES AND GENERAL USES. Conn. Agr. Expt. Sta. Bul. 527.

---------- and Spencer, R. A.
1953. AIR-BLAST SPRAYING APPARATUS FOR HELICOPTERS. Jour. Econ. Ent. 46 (1): 147.

Schaffner, J. V., Jr.
1953. ELM LEAF BEETLE.
U. S. Dept. Agr. Leaflet 184 (Revision).

1953. CANKERWORMS.
U. S. Dept. Agr. Leaflet 183 (Revision).

Bean, James L.
A new matsucoccus scale infesting red pine in southern Connecticut and New York. (Approved for publication in Jour. Econ. Ent.)

Jaynes, H. A.
Parasitization of the spruce budworm by apanteles and glypta at different crown heights. (Approved for publication in Jour. Econ. Ent.)

Schaffner, J. V., Jr.
Host plant--common name index.
(Supplement for U. S. Dept. Agr. Misc. Pub. 657; Approved and in galley.)

Potts, S. F.
Precision equipment and methods for field testing of insecticides. (In manuscript.)

Waters, W. E., McIntyre, T., and Crosby, D.
Loss in volume of white pine in New Hampshire caused by the white pine weevil. (Approved for publication in Jour. Forestry.)

FOREST DISEASE INVESTIGATIONS

Report from the Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering, 360 Prospect Street, New Haven, Conn.

DURING 1953 THE New Haven station of the Division of Forest Pathology continued studies on the disease susceptibility of hybrid-poplar clones, the surface sterilization of poplar cuttings, the role of fungi in causing excessive mortality of birch, the effect of decay on pulpwood floatability, and the preparation of indexes of forest-tree diseases. Studies and surveys also have been made on the European larch canker in eastern Massachusetts, Phomopsis canker of white pine and other conifers, Valsa canker of conifers, oak wilt, Urnula-Strumella canker of oak, and wilt of yellow-poplar.

Disease Susceptibility Of Hybrid-Poplar Clones

From inoculations with the canker-producing fungus, Septoria musiva, on hybrid-poplar clones in the Forest Service plantings at the Virginia Pine-Hardwood Research Center at Laurel, Md., 53 clones of various parentages showed evidence of resistance to infection. Forty-four of these clones were retested by inoculations at the Hopkins Experimental Forest, Williamstown, Mass.; and the results indicated the same resistance.

These latter clones were also inoculated with another canker-producing fungus, Dothichiza populea. About 60 per-

cent of these clones showed some degree of susceptibility, but many of the susceptible clones were able to counteract infection by the production of callus. The final results of these inoculations and other data concerning the importance of Dothichiza in the breeding of hybrid poplars will be prepared for publication.

Data concerning the Septoria canker of hybrid poplars, including the rating of susceptibility of clones, have been submitted for publication as a U. S. Department of Agriculture circular or technical bulletin with the title "Septoria canker of poplars in the United States."

Surface Sterilization Of Poplar Cuttings

The experiments conducted in 1952 on the control of fungus diseases transmitted by spores on dormant cuttings were continued. In addition to 5-percent mercuric chloride solution in 70 percent alcohol, 11 fungicides were tested for their effect upon spores that might be imbedded in the resinous coating of the buds or lying free in the lenticels.

Phytotoxicity also was tested by planting in the greenhouse dormant cuttings treated by dipping in the test solutions. Satisfactory fungicidal effect was obtained by dipping in a 1-percent solution of Semesan or in a 2-percent solution of Ceresan M. No phytotoxicity resulted from these two fungicides. Cuttings treated with the mercuric chloride solution in alcohol were slightly retarded in growth. To test possible phytotoxicity under field conditions, cuttings treated with the mercuric chloride, Semesan, and Ceresan M were shipped to the Research Center at Laurel, Md., to be planted in the nursery plot.

The results of the fungicidal tests and the greenhouse plantings have been submitted for publication in the Plant Disease Reporter as "Additional information on the surface sterilization of poplar cuttings."

Dieback Of Birch

Investigations of the relation of fungi to the dieback of yellow and paper birch have been completed. None of the numerous fungi isolated from twigs, branches, or stems of diseased trees has proved to be parasitic when inoculated into healthy trees. A fungus tentatively identified as Cylindrocarpon orthosporum was isolated frequently from roots of dieback birch. The possible parasitism of the fungus when placed in contact with roots of young trees was tested by heavily inoculating the soil in which potted saplings of yellow and paper birch were growing in the greenhouse. No dieback has occurred in any of the saplings during

the year following inoculation. A detailed report of the fungi isolated from all portions of the birch dieback trees and their relation to the disease will be prepared for publication.

The 138 birch survey plots established in 1949, in cooperation with the Division of Forest Insect Investigations, were reduced in number to 74 plots in 1953, of which all were reexamined. In the 4-year period since establishment, of the yellow birch 4.7 percent of the dominant and codominant trees have died, and of paper birch 2.4 percent of the dominant trees and 3.3 percent of the codominant trees have died. For the intermediate and suppressed trees of both species, mortality has been considerably higher. The average loss for both species in all crown classes is 7.0 percent.

In 1953, as in 1952, reduction of the rate of deterioration of both yellow and paper birch has continued, but yellow birch is responding less rapidly to the improved conditions than paper birch.

Decay In Pulpwood
In Relation To Floatability

Information on the decay and causal fungi isolated from the balsam fir logs used in the floatability study was correlated with similar data from a previous study on deterioration in balsam fir and spruce trees following attacks by spruce budworm. These data, with additional information on balsam fir decays in eastern North America assembled by Canadian investigators, were published in the Canadian Journal of Botany in May 1953.

The analysis of data obtained from the study of floatability of balsam fir and spruce logs, with reference to species of tree, type of decay, position of the bolts in the tree, and degree of seasoning, is being prepared for publication as a U. S. Department of Agriculture circular or miscellaneous publication.

Forest Tree-Disease Indexes

About 40,000 cards were added to the index of forest-tree diseases during the year. A special effort has been made to give adequate coverage to current publications and at the same time to index older publications throughout the world. Preliminary reports are being prepared listing the species and locations of North American trees (north of Mexico) planted abroad, with annotations on their potential value where planted, along with a summary of the diseases reported on them.

European Larch Canker
In North America

In September-December 1952 and March-May 1953 an intensive survey was made of larch trees on estates in eastern Massachusetts to determine whether the destructive European larch canker caused by Dasyscypha willkommii had been effectively eradicated from that area. No survey of this locality, which is the only known area of infection in the United States, had been made since 1939.

Particular attention was paid to the trees on the six estates where infection was found in 1935-39. In the 1952 survey, six infected European larches were found on two of these estates. These and 16 other nearby larches were removed and destroyed. A total of 2,050 other European larches were free from the disease. No infection by the fungus was found on 1,700 Japanese larches and 7 American larches. A large group of American larch trees in a swampy area on one of the estates will be examined whenever the freezing of the swamp makes them accessible.

Phomopsis Canker Of White Pine
And Other Conifers

In the study of the relation of the fungus Phomopsis strobi to cankers on white pine and other conifers, inoculations were made in the summer of 1953 on established nursery trees of white pine, Douglas-fir, Fraser fir, Norway spruce, Colorado blue spruce, white spruce, and hemlock.

A total of 420 inoculations were made with five isolates of the fungus from American material. In addition, 10 isolates of the same fungus, which was received from Norway under the names Phomopsis pseudotsugae and Discula pinicola, were used in 420 inoculations. The same 15 isolates were used also in 381 inoculations in the fall. White pine, Douglas-fir, and Japanese larch saplings in another planting were similarly tested in August and October with 187 inoculations.

A series of early spring inoculations are planned in 1954. The results of the inoculations, together with a detailed description of Phomopsis strobi and its perfect stage, hitherto unreported, will be prepared for publication.

Valsa Canker Of Conifers

During the past decade, observations and inoculations have been made with the species of Valsa isolated from cankers on conifers in ornamental plantings and in forest plantations to determine their parasitism and possible interrelation. The host species commonly infected are spruce (five species), Douglas-fir, white fir, balsam fir, European larch,

hemlock, white pine, and Himalayan pine. The fungus on the hosts was tentatively described as Valsa kunzei.

Morphological studies carried on in cooperation with Dr. Lewis Wehmeyer of the University of Michigan, Ann Arbor, Mich., suggest that three distinct varieties of the Valsa species may be involved. Results of cultural studies and cross-inoculations also seem to indicate distinguishing varietal characteristics. Data from these observations and studies are being prepared for publication.

Oak Wilt

Aerial surveys to discover oak wilt infections were conducted in 1953 as in previous years. In the Northeast, the over-all distribution of oak wilt has remained unchanged, no infections being found east of the Susquehanna River in Pennsylvania, or in New Jersey, New York, and New England.

Examination of the plots in Pennsylvania on which tree poisons were applied by helicopter to test the feasibility of this method of oak wilt control showed that it has promise, but more time must elapse before the results can be completely evaluated. Two poisons, 2,4,5-T and CMU, were applied in September 1952. Apparent mortality of oaks in varying degrees has been recorded in all tests, but whether or not the roots have been killed, or whether or not the crowns are completely killed, cannot be determined until another growing season has passed.

Urnula-Strumella Canker Of Oak

Cankers caused by Strumella coryneoidea sometimes occur on young trees of various species of oak in the Northeast and occasionally also on other hardwood species. Recently a fungus that has been described as Urnula craterium, occurring on fallen oak logs, was found to resemble the Strumella in culture. It was suggested that the Urnula might be the perfect stage of the Strumella.

In field tests at Norfolk, Conn., and New Haven, Conn., red oaks were inoculated in 1950 and 1951 with four isolates of Strumella and five of Urnula. Typical Strumella cankers with fruiting pustules developed from several of the inoculations with the Urnula and the Strumella isolates, indicating that they are two stages of the same fungus.

This is of particular significance in the control of the disease, since all diseased trees removed in thinning operations should be used or destroyed and not allowed to remain on the ground where conditions would be favorable for the development of the Urnula stage. The results of this study will be prepared for publication.

Wilt Of Yellow-Poplar

A disease of yellow poplar in the New Haven area has been under observation; and a fungus, a species of Verticillium, was isolated from wilting twigs and branches. A wilting of the leaves during the late summer and the dieback of entire branches with greenish-black streaks in the wood are the principal symptoms.

Inoculations of young twigs of trees in a nursery plot gave positive results in a few cases. The study will be continued with additional inoculations, and with observations concerning the severity of the disease and the conditions under which it may occur.

Publications

Basham, J. T., Mook, P. V., and Davidson, A. G.
1953. NEW INFORMATION CONCERNING BALSAM FIR DECAYS IN EASTERN NORTH AMERICA. Canad. Jour. Bot. 31: 334-360.

Fowler, M. E., and Aldrich, K. F.
1953. RESURVEY FOR EUROPEAN LARCH CANKER IN THE UNITED STATES. Plant Dis. Rptr. 37: 160-161.

Hansbrough, J. R.
1953. STORAGE OF NORTHERN HARDWOOD LOGS AND BOLTS. Rpt. 13th Vt. Wood Prod. Conf.: 31-39. Norwich Univ., Northfield, Vt.

1953. STORAGE OF NORTHERN HARDWOOD LOGS AND BOLTS. Jour. Forest Prod. Res. Soc. 3 (3): 33-35, 92.

Forest Inventory

FIELD CREWS SURVEYED about 6,900,000 acres in the Northeast in 1953. Nearly 53,000,000 acres have now been covered by field inventory--about 70 percent of the initial survey job. The field inventories have been completed in the states of Connecticut and Rhode Island, and only 10 percent of Massachusetts remains to be done. Work continued in Pennsylvania, where 77 percent of the job is now completed.

State cooperation has been excellent. New aerial photography was provided by Pennsylvania, Massachusetts, Rhode Island, and Connecticut. Office space has been made available by the states and by Harvard Forest at Petersham, Massachusetts.

Type Maps

Field type-mapping has been kept up to date with the exception of a few counties in Pennsylvania. These are now being typed.

Commodity Drain

During the first part of the year, woods-utilization studies were completed in Pennsylvania, New Jersey, Massachusetts, and Connecticut. The Commonwealth of Pennsylvania finished a commodity-production survey patterned after those undertaken by the Station. The data will be used in the forest-survey drain estimates.

Considerable data were collected on various types of woods operations throughout the Station territory. These data will be used to determine the percentage of various products being cut from sawtimber- and poletimber-size trees.

During the latter part of the year nearly all drain work has been concerned with getting and compiling data for the Timber Resource Review. Reliable estimates of production have been obtained for most states. Much of this information will be of use in the regular survey drain studies.

Reports

Seven unit reports for West Virginia and the unit reports for Central Maryland and District 3 of New York were published during the past year. Unit reports for the 12 remaining districts in New York were prepared and are ready

for printing.

The final forest-resource reports for New Hampshire and West Virginia have been submitted for publication. Preliminary drafts of similar reports for Vermont and Maryland have been prepared. Plans were made to write an analysis of the forest-resource situation in New York in cooperation with the State College of Forestry at Syracuse.

Special Projects

A report was published on the results of an airphoto method of estimating commodity drain by using two sets of photos taken at different times. Also published were results of tests showing that in photo interpretation cubic-foot volume classes are better than stand-size classes for meeting an accuracy standard in cubic feet.

Pulpwood specifications, for forest-survey purposes, were developed in cooperation with the Appalachian Technical Committee of the American Pulpwood Association.

During the year 93 inquiries were received and answered regarding information available from forest-survey sources.

FOREST ECONOMICS

ALTHOUGH THE FOREST SURVEY is the major project of the Station's Division of Forest Economics, there were a number of lesser projects under way in 1953.

One of these had to do with compartment-study techniques and analysis. During the year a comprehensive set of instructions for compartment record-keeping was developed.

Marketing Of Forest Products

In cooperation with eight Agricultural Experiment Stations, the Station has been participating in a regional investigation of the marketing of forest products. In addition to its part in the planning of this investigation, the Station has conducted all the field work in Rhode Island and Delaware, and assisted with some of the field work in New Jersey and Connecticut.

A report was published on the pole and piling situation in the Northeast--specifications, prices, producers, and dealers. The report points out that the Northeast produces about 70 percent of the piling, but only about 3½ percent of the utility poles that it uses.

Some time ago the Station devised a scale stick for grading hardwood logs; this has proved to be very popular in the region. The design of this stick was improved during the year.

Tests were conducted of various log-grading systems applicable to hard pines growing in the southern parts of the region.

Other Projects

Some preliminary data were supplied to the Agriculture Field Committee for the study of forest resources in the New England-New York area. And some help was given to the committee in preparing economic evaluation of benefits and costs from forestry programs.

The Station cooperated with the Society for the Protection of New Hampshire Forests and with the Governor's Timber Tax Study Committee on developing data to be used as a basis for tax reimbursement in New Hampshire.

Opportunities in forest leasing were analyzed with the thought that leasing might be a useful device for grouping small holdings into larger operating units of more efficient size.

FOREST UTILIZATION

THE ACTIVITIES OF the Station's Forest Utilization Service during 1953, as in previous years, had the broad objective of improving the utilization system and thus increasing the possibility of applying sound forest management to the forests of the region. Because a free flow of latest technical information is one means to this end, the Forest Utilization Service this year gave special emphasis to working with the many groups in the field.

We made an intensive study of utilization research for the New England Council's subcommittee on Forest Research. This showed that there is an important job to be

done in coordinating effort and in giving leadership to research in logging and transportation of forest products. Earlier Station studies indicated that timber operators in the Northeast use three times as much manpower and twice as much capital per unit of product as do operators in the Western States. Current research in the field of logging is meagre; more would be fruitful.

Th help in this field, U. S. Department of Agriculture Farmers' Bulletin No. 2008, which dealt with logging problems on small operations, was revised. More than 80 people, including Extension Foresters, other Forest Utilization Service units, the Forest Products Laboratory, forestry school faculties, and industry representatives advised on this job.

In addition, members of the Forest Utilization Service unit served on a Forest Products Research Society--American Society of Mechanical Engineers Committee, which had undertaken, for the American Standards Association, the formulation of performance standards for small sawmills. They were also active on a national committee of the Forest Products Research Society dealing with logging and milling, and the board of directors of the Northeastern Loggers' Association.

Forest Utilization Service personnel worked closely with the Forest Products Research Society in other activities, arranging meetings at Portland, Maine, and New Haven, Connecticut, where some 25 papers on wood-waste utilization, structural laminating, plant safety, integrated logging, industry training, and related problems were given.

The Forest Utilization Service participated in and helped arrange programs for four meetings of the Keystone and New England Kiln Drying Associations. In company with the latter association, the Station sponsored and participated in a 1-week intensive field-demonstration course in modern kiln-drying techniques, given by Forest Products Laboratory technicians at the University of Massachusetts. It participated in a series of nine demonstration clinics for sawmill men in New Hampshire, arranged by the New Hampshire Extension Service, with technical assistance of the Forest Products Laboratory. Arrangements were also made under which a Forest Products Laboratory representative held five clinics (for state, federal, and private foresters), dealing with the silvicultural factors influencing timber growth and wood quality. Meetings were held in West Virginia, Pennsylvania, New Hampshire, and New York State. The Forest Utilization Service also gave a course in hardwood log-grading for Pennsylvania state foresters and millmen.

A field of wood use that is important now and promises to become more so in the future is the use of wood

chips for agriculture. Station representatives attended conferences with Agricultural Research Administration officials and the Northeastern Wood Utilization Council dealing with this subject.

The Northeastern Wood Preservation Conference met at the Connecticut Agriculture Experiment Station in New Haven, Connecticut. This group originally met last year to determine the feasibility of a coordinated research program in this field. At its second meeting the group felt that the effort should be broadened to include such things as studies of treating specifications and problems of non-pressure treating, as well as basic research.

The Station continued its efforts in stimulating and publishing a series of papers to encourage the utilization of American beech. This project is in cooperation with the Northeastern Technical Committee on the Utilization of Beech. Five papers were published during the year, bringing the total to eight. Another eight are well along in editing.

Working as it does with many agencies and institutions, and serving as an outpost of the Forest Products Laboratory, the Station's Forest Utilization Service maintains reasonably close contact with significant utilization developments in the region and elsewhere. Among those with which especially close touch was maintained were the following: The bolter-produced dimension business, (in cooperation with the Forest Products Laboratory and the State University of New York College of Forestry); use of native lumber in rural buildings (University of Connecticut's Poultry House Workshop); charcoal-production problems (in cooperation with the Forest Products Laboratory); separation of bark from chips produced from unbarked slabs (in cooperation with the Michigan School of Mining and Technology and U. S. Eastern Regional Research Laboratory); progress on chemical-debarking studies (in cooperation with the American Pulpwood Association and New York State Conservation Department); and logging damage (in cooperation with U. S. Forest Service Region 7).

Arrangements were made for tests of California hardwoods by Northeastern commercial wood turners and for test material to be supplied to the Forest Products Laboratory for use in experiments on natural decay-resistance of native woods. Assistance was given to the Bureau of Plant Industry, Soils, and Agricultural Engineering in studies of sawdust as a soil conditioner, and to the Connecticut Agricultural Experiment Station in tests of a spectrographic method for quantitative analysis of preservative-salt retention in treated wood.

In connection with the Timber Resource Review, studies were made of commodity production and current disposition of primary wood-using industry residues. In this work,

the various state forest services aided tremendously with manpower and, in the case of one state, with a cash allotment as well. The data obtained will give comprehensive regional and state pictures of the opportunities for developing uses for residues now wasted.

The flow of requests for information from individuals and firms continued as in past years. These ran the gamut of the field, varying from problems in gluing split wooden stadium seats to methods of felling trees. Representatives of the British Forest Service, the Swedish Institute of Forest Utilization Studies, Formosa's Taiwan University and Forest Research Institute, the Venezuelan State University, and the Pakistan Forest Service visited the Station to discuss utilization methods.

PUBLICATIONS

by staff members and cooperators of the
Northeastern Forest Experiment Station,
Forest Service, U. S. Dept. Agriculture

*Banks, Wayne G.
1953. FOREST STATISTICS FOR CENTRAL MARYLAND.
Northeast. Forest Expt. Sta., Forest Statis. Ser.: Md. 2. 19 pp., illus.
Forest-survey findings for the central section of Maryland: forest area, timber volume, forest types, and condition of the forests. Tabular data and brief text.

Barraclough, Solon.
1953. MAKE NEW HAMPSHIRE FORESTS PAY.
Univ. N. H. Alumnus 29 (6): 14-17, 22, illus.
The Governor's Forest Policy Committee found that New Hampshire's forests are in generally poor condition. Four approaches to the forest problem are suggested: research, education, encouragement to forest owners, and voluntary control of cutting and utilization practices.

*Bethlahmy, Nedavia.
1953. ESTIMATING SUMMER EVAPO-TRANSPIRATION IN A PENNSYLVANIA SCRUB OAK FOREST. Soil Sci. Soc. Amer. Proc. 17: 295-297, illus.
Soil moisture was measured with fiberglas units, and losses were calculated daily for periods when all gravitational water had drained out. The relationship between the losses and certain soil and climatic factors was determined, and evapo-transpiration losses were calculated without need for direct measurement. A water balance was worked out for the sample watershed.

*---------
1953. TECHNICAL ARTICLES.
Jour. Forestry 51: 911.
Proposes that every article published in the Journal of Forestry be accompanied by an abstract to enable the busy reader to become acquainted with the contents of more articles than he normally would have time to read.

---

*Copies or reprints available from the Northeastern Forest Experiment Station, 102 Motors Avenue, Upper Darby, Pa.

*Bethlahmy, Nedavia.

1953. DISCUSSION OF "FROST PENETRATION INTO SOILS AS INFLUENCED BY DEPTH OF SNOW, VEGETATIVE COVER, AND AIR TEMPERATURES" BY CLYDE E. BAY, GEORGE W. WUNNECKE, AND ORVILLE E. HAYS. Amer. Geophys. Union Trans. 34: 635-637.

Gypsum blocks can be used to measure movement of frost into and out of the soil. But resistance alone does not tell all about the frost: for each soil a detailed analysis must be made to determine type of frost. Another factor that must be considered is a frozen soil's drawing moisture from lower unfrozen horizons, thus changing the type of frost.

*Bickford, C. Allen.

1953. INCREASING THE EFFICIENCY OF AIRPHOTO FOREST SURVEY BY BETTER DEFINITION OF CLASSES. Northeast. Forest Expt. Sta., Sta. Paper 58. 9 pp.

Tests of forest-survey methods showed that cubic-foot volume classes are better in photointerpretation than stand-size classes for meeting an accuracy standard in cubic feet. Efficiency could be increased by (1) using identical areas for both photointerpretation and ground examination; (2) increasing the size of ground plots; and (3) using classification instead of delineation in timber cruising.

*---------

1953. USE OF AERIAL PHOTOGRAPHS IN ESTIMATING DRAIN. Northeast. Forest Expt. Sta., Sta. Paper 59. 10 pp.

An airphoto method of estimating commodity drain was tested, using two sets of photos (11-year interval). The method has some advantages over conventional methods, is easy to use, and costs less. Choice of method will depend on what kind of drain information is needed and what is available from other sources.

*---------

1953. AN AID IN CHOOSING THE RIGHT TREE TO LEAVE. Northeast. Forest Expt. Sta., Sta. Paper 64. 8 pp.

Describes development and operation of a slide-rule device the forester can use in deciding which trees to leave in a selective cutting. The slide rule is based on present diameter and estimated growth in the next 10 years, and it can be used to estimate (1) the interest rate a tree is now earning or (2) what growth is required to earn a set rate of interest. Prepared for yellow-poplar in West Virginia.

Church, Thomas W. Jr.

1953. HEAVY SEED CROP FORECAST FOR VIRGINIA PINE IN 1953. Northeast. Forest Expt. Sta. Res. Note 20: 1-2, illus.

Observation of seed fall at the Beltsville (Md.) Experimental Forest indicates a periodicity of seed production by Virginia pine. From the number of immature cones observed in 1952, an unusually good seed crop was forecast for 1953.

*---------

1953. A VOLUME TABLE FOR VIRGINIA PINE IN PRINCE GEORGES COUNTY, MARYLAND. Northeast. Forest Expt. Sta. Res. Note 22. 3 pp.

Virginia pine has become commercially important, and cubic-foot volume tables are needed by the forester for managing stands of this species. The author provides a local volume table.

*---------

1953. CONVERTING VIRGINIA PINE STUMP DIAMETERS TO DIAMETERS BREAST HIGH. Northeast. Forest Expt. Sta. Res. Note 23. 2 pp., illus.

Little forest-management work has been done with Virginia pine. To help the forester, stump-d.b.h. relationships were worked out on the Beltsville Experimental Forest in Maryland. The relationships are shown graphically.

*Cook, David B.

1953. BEECH FOR CONTAINERS. Northeast. Tech. Com. on Util. Beech and Northeast. Forest Expt. Sta., Beech Util. Ser. 7. 13 pp., illus.

Beech is an excellent wood for baskets and wire-bound boxes. It turns well and gives a good yield of tight veneer that makes tough, pliable, bright, and odor-free slats. It can be used in containers for all sorts of foods. The author suggests what can be done both in the woods and in the mill to improve utilization of beech for containers.

*Cunningham, Frank E.

1953. ROOTING ABILITY OF NATIVE COTTONWOODS DEPENDS ON THE CLONE USED. Northeast. Forest Expt. Sta. Res. Note 26. 2 pp.

Native cottonwood cuttings from two sources were compared with hybrid poplar clones in rooting ability. Great differences were found between the cottonwood clones from the two sources. The hybrid poplar clones rooted best and with greatest uniformity. Tests made at Williamstown, Mass.

Curry, John R.

1953. FOREST MANAGEMENT PROBLEMS AND RESEARCH IN THE CENTRAL ADIRONDACKS. N. Y. Forester 10 (2): 7-10. (N. Y. Section, Soc. Amer. Foresters.)

Lack of markets, difficult transportation, overmature timber, and tax burdens are some of the forestry problems in the Adirondacks. Research aimed to solve these problems is carried on by the Northeastern Station at its research center at Paul Smiths, N. Y. The research program is described.

1953. EARLY LUMBERING IN THE ADIRONDACKS. Northeast. Logger 1 (9): 13, 22.

Reviews history of lumbering as presented in "Township 34" by Harold K. Hochschild (published by author). The lumbermen were largely responsible for opening up the Adirondacks. They developed their own methods and tools--some of them unique--to fit Adirondack conditions.

Fenton, R. H.

1953. PROFIT FROM THINNINGS. Amer. Forests 59 (2): 23, 51, illus.

The owner of a red pine plantation treated thinning products with preservatives ("barrel treatment" and "stepping method") and found profitable specialty markets for them--rustic gateways and highway posts.

*---

1953. SIMPLE MEASURING DEVICE SPEEDS PULPWOOD CUTTING. Northeast. Forest Expt. Sta. Res. Note 19: 3-4, illus.

A telescoping radio antenna, attached to a chain saw with a simple bracket, enables the pulpwood bucker to measure and cut in one operation. The device has been found to save 20 minutes for every cord of wood cut.

1953. CHAIN SAW MEASURING-ROD ATTACHMENT. Northeast. Logger 1 (8): 17, illus. (See above.)

*Fleischer, H. O.

1953. BEECH FOR VENEER AND PLYWOOD. Northeast. Tech. Com. on Util. Beech and Northeast. Forest Expt. Sta., Beech Util. Ser. 6. 24 pp., illus.

Beech veneer and plywood can be used effectively in furniture and other products, but special attention must be paid to moisture conditions in preparing the logs and manu-

facturing veneer and plywood products. Technical problems are discussed. Results of exposure tests of beech plywood show tendency to delaminate, check, and warp.

Fridley, Burley D.
1953. HOME-MADE GADGETS AID FOREST-INFLUENCES RESEARCH. Jour. Forestry 51: 907-908, illus.

Three home-made devices have proved helpful in research studies: (1) an ordinary bucket made into a simple stove for thawing ice and snow in rain gages; (2) a spring clamp for holding a measuring tape to a stake; and (3) a portable datum level for measuring erosion on logging roads.

*Hart, A. C.
1953. SMALL-FOREST MANAGEMENT IN THE SPRUCE-FIR REGION. Northeast. Forest Expt. Sta. Res. Note 21. 4 pp.

Three improvement cuttings were made in a small-forest study in Maine to build up growing stock, improve stand conditions, increase growth, and improve stand structure by making frequent light cuttings. Profits were shown in the improvement cutting.

*Hough, A. F.
1953. PRELIMINARY RECOMMENDATIONS FOR THE MANAGEMENT OF BLACK CHERRY ON THE NORTHERN ALLEGHENY PLATEAU. Jour. Forestry 51: 184-188, illus.

Black cherry produces plenty of seedlings, but few of them survive to become crop trees. The author found that clear-cutting of narrow strips or small openings is an effective way to regenerate full stands of black cherry third growth.

Larson, E. vH.
1953. BIRTHDAY CAKE FOR AN ACT OF CONGRESS. Pa. Forests 38 (3): 4, 20.

The McSweeney-McNary Act of 1928, authorizing Federal experiment stations and cooperative research, was a turning point in forest research. As an example of progress under the Act, the growth of the Northeastern Forest Experiment Station is traced from a few simple projects to an integrated research program that involves a wide range of research activities in forestry and related fields.

*Lefkof, E. A.
1953. BEECH FOR FLOORING. Northeast. Tech. Com. on Util. Beech and Northeast. Forest Expt. Sta., Beech Util. Ser. 8. 11 pp., illus.

In strength and durability, beech is comparable to maple for use as flooring; it can be used in industrial plants and public buildings where it gets the severest wear.

In color and general attractiveness it is fitting for the finest homes. The qualities of the wood, and the manufacture, installation, and finishing of beech flooring are discussed.

*Little, Silas Jr.

1953. PRESCRIBED BURNING AS A TOOL OF FOREST MANAGEMENT IN THE NORTHEASTERN STATES. Jour. Forestry 51: 496-500.

Describes use of prescribed burning in southern New Jersey and Eastern Shore Maryland, including species characteristics that modify fire effects; effect of wild fires on stand composition; effect of prescribed fires on stand composition; and effect of prescribed burning on growth, site, and game.

1953. PRESCRIBED BURNING IN NEW JERSEY AND MARYLAND. N. Y. State Ranger School Alumni News 1952: 18-21.

General description of use of prescribed fire for preparing seedbeds favorable for establishment of pine seedlings. Effects of fire on soils and game are explained, and problems in carrying out a prescribed-burning program are discussed.

*---------- and Moore, E. B.

1953. SEVERE BURNING TREATMENT TESTED ON LOWLAND PINE SITES. Northeast. Forest Expt. Sta., Sta. Paper 64. 11 pp.

A hot, deep-burning fire was tried in a prescribed-burning treatment on a New Jersey forest tract that was mostly on lowland sites. Used in a seed year, this unusual treatment seems to be highly effective for reproducing pine on wet and medium sites of pine lowlands in New Jersey.

---------- Somes, H. A., and Allen, J. P.

1953. CHOOSING SUITABLE TIMES FOR PRESCRIBED BURNING IN SOUTHERN NEW JERSEY. U.S. Forest Serv. Fire Control Notes 14 (1): 21-25.

Prescribed use of fire as a silvicultural tool is still more art than science, and experience and skill are needed for getting the proper intensity of fire. The fire-danger-rating system can be used as a general guide, but in case of doubt a small test fire should be used.

*McConkey, Thomas W.

1953. GROWTH BEHAVIOR OF WHITE PINE IN AN UNCUT STAND IN SOUTHWESTERN MAINE. Northeast. Forest Expt. Sta. Res. Note 25 3 pp.

Analysis of growth (in both board feet and percentage) of a white pine stand over a 15-year period. Trees in

each species and diameter class were divided into three growth classes (fastest to slowest). Here 20 percent of the trees produced 48 percent of the annual per-acre growth. The number of years needed to grow 1 inch in diameter is given as a guide to thrift and condition.

McGuire, John R.
1953. WHAT WILL THE PULP MILLS BUY?
Northeast. Wood Util. Council Bul. 40: 17-22.
Outlines specifications for pulpwood markets in the Northeast: species, size, defects, peeling, splitting, and piling of boltwood. Products of integrated logging, pulpwood contracts, and stumpage sales are also discussed.

1953. WHAT WILL THE PULP MILLS BUY?
Pulp and Paper Mag. Canada 54 (3): 284-288.
(See above.)

Marquis, Ralph W.
1953. HOW UNCLE SAM'S RESEARCH HELPS THE LUMBERMEN.
Northeast. Logger 2 (4): 10-11, 55, illus.
Because the lumbering industry of the Northeast is made up mostly of small operators, most of the research is done by the schools, research foundations, states, or Federal government. The research activities of the U.S. Forest Service, carried on by the Northeastern Forest Experiment Station, are described.

*Northeastern Forest Experiment Station.
1953. ANNUAL REPORT 1952.
Northeast. Forest Expt. Sta. 71 pp.
Highlights of the forest-research activities of the Northeastern Station and its cooperators in 1952.

*---
1953. FOREST STATISTICS FOR NEW YORK FOREST DISTRICT No.3.
Northeast. Forest Expt. Sta., Forest Statis. Ser.: N.Y. 3. 19 pp.
Forest-survey findings for Forest District No. 3 in central New York: forest area, timber volume, forest types, and condition of the forests. Tabular data and brief text.

*---
1953. FORESTRY DEMONSTRATION ON THE BARTLETT EXPERIMENTAL FOREST. Northeast. Forest Expt. Sta. 4 pp., illus.
A leaflet describing briefly the cutting practices and other forestry studies under way on the Bartlett Experimental Forest near Bartlett, N. H.

Northeastern Forest Experiment Station.

1953. BARTLETT EXPERIMENTAL FOREST.
Soc. Protect. N. H. Forests, Forest Notes 38: 5-7, illus.
(See above.)

*---------

1953. THE KANE EXPERIMENTAL FOREST.
Northeast. Forest Expt. Sta. 4 pp., illus.
A leaflet describing briefly the cutting practices and other forestry studies under way on the Kane Experimental Forest near Kane, Pa., on the Allegheny Plateau.

*Olson, W. Z., and Blomquist, R. F.

1953. GLUING TECHNIQUES FOR BEECH.
Northeast. Tech. Com. on Util. Beech and Northeast. Forest Expt. Sta., Beech Util. Ser. 5. 20 pp.
Laboratory tests and industry experience show that beech does not present any greater gluing problems than comparable species of high density. Offers recommendations for selection of glue, proper gluing conditions, preparation of wood and glue, glue application, assembly time, temperature, pressure, and conditioning after gluing. Inspection and control methods are outlined.

*Ostrander, Myron D.

1953. PRODUCTION AND MARKETING OF WOOD PILING AND POLES IN THE NORTHEAST. Northeast. Forest Expt. Sta., Sta. Paper 57. 23 pp., illus.
The Northeast produces 70 percent of the piling it needs, and $3\frac{1}{2}$ percent of the utility poles. Methods of producing, treating, and marketing poles and piling are described; and specifications and price ranges are outlined. Includes directory of producers and dealers.

*---------- and Englerth, G. H.

1953. HARDWOOD LOG GRADING SCALE STICK IMPROVED.
Northeast. Forest Expt. Sta. Res. Note 24. 2 pp.
A scale stick devised for use as an aid in grading hardwood logs has been improved by incorporating features of a similar stick designed at the Southeastern Forest Experiment Station. Detailed full-scale plans of the stick are available.

Reigner, Irvin C.

1953. DO NOT PLANT TREES TOO SOON AFTER USING WEED KILLERS.
Northeast. Forest Expt. Sta. Res. Note 20: 3-4.
Herbicides (2,4,5-T and 2,4-D) used to prepare planting spots by killing competing vegetation killed the planted tree seedlings too. It is suggested that 6 months

be allowed between herbicide treatment and planting. Species affected were red pine, jack pine, pitch pine, Japanese larch, black cherry, and yellow-poplar.

Ritter, George J.
1953. THE CHEMISTRY AND CHEMICAL UTILIZATION OF BEECH. Jour. Forest Prod. Res. Soc. 3 (3): 79-84.
Technical data on chemical composition of beech wood, bark, and beechnuts; and discussion of chemical utilization of beech wood for wood sugars, molasses, yeast, alcohol, and destructive-distillation products such as gases, pyroligneous acid, and tars. Use of beech for chemically modified wood products is also discussed.

*Rutherford, William Jr.
1953. RELATIVE EASE OF PEELING BEECH, RED MAPLE, AND YELLOW BIRCH. Northeast. Forest Expt. Sta. Res. Note 19: 1-2.
Studies of peeling in the Adirondacks showed that yellow birch and red maple are as easy to peel as spruce or fir, and peeling them is clean work--no pitch or resin to gum up tools, hands, and clothes. Beech was hard to peel.

*Scheffer, Theodore C., and Jones, T. W.
1953. CONTROL OF DECAY IN BOLTS AND LOGS OF NORTHERN HARDWOODS DURING STORAGE. Northeast. Forest Expt. Sta., Sta. Paper 63. 15 pp., illus.
Logs and bolts can be stored safely for long periods in fresh water. Storage under wet hay gives moderate protection; use of water spray is promising enough to merit further trial. Chemical controls recommended include spray (on log ends) with fungus-inhibiting chemical solution; and use of vapor-resistant end-coatings to prevent seasoning checks.

Simmons, Fred C.
1953. AIR DRYING IN UNIT PACKAGES.
Vt. Wood Prod. Conf. Proc. 12 (1952): 5-14, illus.
With modern lumber-yard methods, the best way to handle lumber is in unit packages that can be moved about intact from mill to drying yard to dry kiln to storage. The problem is to assemble unit packages that will not shake apart in transit. Yard layout and methods of assembling and piling unit packages are described.

1953. HARVESTING PULPWOOD ON SMALL HOLDINGS.
Northeast. Wood Util. Council Bul. 40: 49-59, illus.
Much of the pulpwood used in the Northeast comes from small forest properties, and this creates problems in logging. The author discusses the problems of who should do

the logging, what should be cut, when pulpwood should be cut, and methods and equipment to be used.

Simmons, Fred C.

1953. HAZARDS AND SAFEGUARDS IN SKIDDING AND HAULING. Northeast. Logger 1 (11): 32-34, illus.

Practical suggestions on safe use of horses and tractors for skidding forest products. Tractor operators should be well-trained responsible men. Proper use of the tractor and its accessories--and proper maintenance measures --are outlined. Hazards in loading and truck hauling are also discussed.

1953. HAZARDS AND SAFEGUARDS IN SKIDDING AND HAULING. N.Y. State Coll. Forestry (Syracuse) Logging Safety Conf. Proc: 12-19.

(See above.)

1953. NEW MACHINERY. Northeast. Logger 1 (12): 23, illus.

Brief descriptions of some new types of logging equipment: a plunge-cut bowsaw, a portable circular brush saw, an all-steel log roller, and an automatic safety clutch for sawmills.

1953. POWER CHAIN SAWS. I. SELECTION AND MAINTENANCE. Northeast. Logger 2 (1): 15, 31, illus.

Choosing a chain saw is something like choosing an automobile--a matter of personal preference and good local service facilities. General types are described. The user should follow the manufacturer's instruction book. Some cautions are given on use, daily checkup, and weekly inspection.

1953. POWER CHAIN SAWS. II. MAINTENANCE OF CUTTING CHAIN. Northeast. Logger 2 (3): 10-11, illus.

Describes different types of chain-saw teeth and methods of sharpening each. Light touching-up can be done in the woods with the chain on the saw, but workshop facilities are needed to do a proper sharpening job. Special clamping fixtures should be used. Angles and clearances for different tooth patterns are given.

Simmons, Fred C.
1953. SELECTION AND MAINTENANCE OF POWER CHAIN-SAWS.
South. Lumberman 187 (2345): 270-275, illus.

Advice on choosing, using, and maintaining a chain saw (see above: Northeastern Logger--Power Chain Saws I and II). Also contains a table of specifications of the 1-man chain saws on the market.

1953. TRAINING LABOR FOR WOODS WORK.
South. Lumberman 187 (2336): 68-70.

Logging is a dangerous occupation, and good supervision and training are needed to improve safety conditions. Elements of training are described, and practical training methods are outlined. Special need is seen for training in use of wire rope, tractors, and loading devices.

*---

1953. "WASTE" AT SMALL SAWMILLS IN RELATION TO LOG QUALITY. Amer. Soc. Mech. Engin. Paper No. 53--A-197 (processed preprint). 9 pp., illus.

"Waste" is unavoidable in sawing poor logs, especially small logs. Ways of marketing more of this "waste" are being developed. Relationships of amount of "waste" material to log size and log quality are shown.

1953.--THE QUESTION CORNER. REPLIES.
Northeast. Logger 1 (6): 15.
Northeast. Logger 1 (7): 10 (February).
Northeast. Logger 1 (7): 30-31 (March).
Northeast. Logger 1 (8): 8, illus.
Northeast. Logger 1 (9): 20.
Northeast. Logger 1 (10): 17.
Northeast. Logger 1 (11): 28.
Northeast. Logger 2 (1): 10-11, illus.
Northeast. Logger 2 (2): 15, illus.
Northeast. Logger 2 (3): 15, illus.

Practical answers to loggers' and sawmill operators' questions about equipment and methods. Considerable interest shown in bolter saws, rubber-tired skidding equipment, and debarking methods and machines.

*Trimble, George R., Jr., and Weitzman, Sidney.
1953. SOIL EROSION ON LOGGING ROADS.
Soil Sci. Soc. Amer. Proc. 17 (2): 152-154.

Logging roads in mountainous West Virginia were studied before, during, and after logging. Erosion was related to grade, length of slope, intensity of use, vegetation, soil, and climate. Erosion-prevention measures are

suggested for use in planning, constructing, using, and maintaining skid roads.

*Weitzman, Sidney.
1953. FIVE YEARS OF RESEARCH ON THE FERNOW EXPERIMENTAL FOREST. Northeast. Forest Expt. Sta., Sta. Paper 61. 44 pp., illus.

A booklet describing the Fernow Experimental Forest in West Virginia and the research carried on there. The aim is to integrate watershed management and timber management in this rugged mountain country. Problems of farm-forest management and mine-timber management are also under study.

*----------
1953. MANAGEMENT FOR FARM FORESTS.
W. Va. Conserv. 16 (11): 20-23, illus.

Describes studies of two areas chosen to be managed as farm forests typical of those in West Virginia. Returns from three selective cuttings showed a profit comparable to what a farmer could make by harvesting other farm crops.

*Westveld, Marinus.
1953. EMPIRICAL YIELD TABLES FOR SPRUCE-FIR CUT-OVER LAND IN THE NORTHEAST. Northeast. Forest Expt. Sta., Sta. Paper 55. 64 pp., illus.

To help the forest manager predict future timber yields, a series of yield tables was developed, based on growth factors (site, density, composition, elapsed time since cutting, and effective age). Presented in both cubic feet and cords, the yield tables are for both dominant and secondary softwood sites; they show merchantable volume for various ages of cut-over (years since last cutting). Method of applying the yield tables to a tract of timber described.

*----------
1953. ECOLOGY AND SILVICULTURE OF THE SPRUCE-FIR FORESTS OF EASTERN NORTH AMERICA. Jour. Forestry 51: 422-430.

Using the climax forest as a guide to growing the species best suited to the climate and the site, the author offers a silvicultural system for managing spruce-fir forests. Based on ecological principals, this silviculture is aimed to bring about forests that are inherently healthy and have natural resistance to insects and diseases.

*Williamson, M. J.
1953. YOUNG VIRGINIA PINE RESPONDS TO THINNING AND PRUNING. Jour. Forestry 51: 129.

Because of inability to prune itself, Virginia pine has not been regarded as a high-grade lumber species; but when it does produce clear wood, its lumber is comparable to

that of other yellow pines. The author recommends pruning crop trees (to 8 feet) at 10 years; release thinning; and, 7 years later, complete pruning of butt log and release.

*Wilson, Robert W. Jr.
1953. HOW SECOND-GROWTH NORTHERN HARDWOODS DEVELOP AFTER THINNING. Northeast. Forest Expt. Sta., Sta. Paper 62. 12 pp., illus.

Growth behavior of a typical northern hardwood forest in New Hampshire was studied over a 15-year period after a thinning in 1936. Gains in diameter growth (about 50 percent) were attributed to removal of poor slow-growing trees and extra growing space made for trees left. Even- versus uneven-aged management is discussed: whatever the choice, thinnings should be frequent, and should be started as early as possible.

*Wray, Robert D.
1953. FOREST STATISTICS FOR THE EASTERN PANHANDLE OF WEST VIRGINIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: W. Va. 2. 16 pp.

Forest-survey findings for Berkeley, Grant, Hampshire, Hardy, Jefferson, Mineral, and Morgan Counties: forest area, timber volume, forest types, and condition of the forests. Tabular data and brief text.

*----------
1953. FOREST STATISTICS FOR THE EASTERN SECTION OF WEST VIRGINIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: W. Va. 3. 16 pp.

Forest-survey findings for Pendleton, Pocahontas, and Randolph Counties: forest area, timber volume, forest types, and condition of the forests. Tabular data and brief text.

*----------
1953. FOREST STATISTICS FOR THE SOUTHEASTERN SECTION OF WEST VIRGINIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: W. Va. 4. 16 pp.

Forest-survey findings for Fayette, Greenbrier, Mercer, Monroe, Nicholas, Raleigh, Summers, and Webster Counties: forest area, timber volume, forest types, and condition of the forests. Tabular data and brief text.

*----------
1953. FOREST STATISTICS FOR THE SOUTHWESTERN SECTION OF WEST VIRGINIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: W. Va. 5. 16 pp.

Forest-survey findings for Boone, Kanawha, Lincoln, Logan, McDowell, Mingo, Wayne, and Wyoming Counties: forest area, timber volume, forest types, and condition of the for-

ests. Tabular data and brief text.

*
Wray, Robert D.
1953. FOREST STATISTICS FOR THE WESTERN SECTION OF WEST VIRGINIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: W. Va. 6. 16 pp.

Forest-survey findings for Cabell, Jackson, Mason, Pleasants, Putnam, Roane, Wirt, and Wood Counties: forest area, timber volume, forest types, and condition of the forests. Tabular data and brief text.

*

1953. FOREST STATISTICS FOR THE NORTH-CENTRAL SECTION OF WEST VIRGINIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: W. Va. 7. 16 pp.

Forest-survey findings for Braxton, Brooke, Calhoun, Clay, Doddridge, Gilmer, Hancock, Marshall, Ohio, Ritchie, Tyler, and Wetzel Counties: forest area, timber volume, forest types, and condition of the forests. Tabular data and brief text.

*

1953. FOREST STATISTICS FOR THE NORTHERN SECTION OF WEST VIRGINIA. Northeast. Forest Expt. Sta., Forest Statis. Ser.: W. Va. 8. 16 pp.

Forest-survey findings for Barbour, Harrison, Lewis, Marion, Monongalia, Preston, Taylor, Tucker, and Upshur Counties: forest area, timber volume, forest types, and condition of the forests. Tabular data and brief text.

Wright, Jonathan W.
1953. POLLEN-DISPERSION STUDIES: SOME PRACTICAL APPLICATIONS. Jour. Forestry 51: 114-118.

It is generally assumed that tree pollen travels great distances; but recent studies show that pollen of some forest trees travels only a few hundred feet. Information about the pollen habits of some forest trees can be put to practical use in spacing seed trees, in establishing seed orchards, and in carrying on forest-genetics studies.

*

1953. A SURVEY OF FOREST GENETICS RESEARCH. Jour. Forestry 51: 330-333.

Forest-genetics research in the United States is barely 40 years old, but already proved results are ready to put into practice. A combination of selection and between-species crossing seems to offer the best approach. Practical applications of genetics research are outlined.

*Wright, Jonathan W.

1953. SUMMARY OF TREE-BREEDING EXPERIMENTS BY THE NORTHEASTERN FOREST EXPERIMENT STATION, 1947-1950. Northeast. Forest Expt. Sta., Sta. Paper 56. 47 pp.

Describes the Experiment Station's tree-breeding program, and methods used. Detailed results of breeding studies with maple, ash, yellow-poplar, oak, spruce, fir, and pine. Other known crosses of species studied are also listed.

*---------

1953. NOTES ON FLOWERING AND FRUITING OF NORTHEASTERN TREES. Northeast. Forest Expt. Sta., Sta. Paper 60. 38 pp., illus.

Phenological data for maple, ash, oak, fir, spruce, and pine species in Philadelphia and vicinity. Effects of unfruitfulness on tree-breeding research are discussed, and ways of solving the problems due to unfruitfulness are suggested.

Agriculture - Forest Service - Upper Darby, Pa.
1954